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POSSIBILITIES OF CROSSING SAN FRANCISCO BAY BY ELECTRIC POWER

BY L. R. JORGENSEN.

At present electricity plays an important role in all branches of every day life, and judging from the rapid growth in the past it seems reasonable to expect great things from this form of power in a not very distant future. Almost every machine and vehicle on land can most readily be driven electrically; but so far few attempts have been made to propel ships by means of electric power fed to it through an overhead system or otherwise. There are many cases in existence, where this undoubtedly would be profitable, but it belongs to the future to develop a system of transmission suitable for this class of work.

View of Ferry Building and San Francisco Bay.

The writer while crossing San Francisco Bay every day has often wondered if this kind of transportation was the best possible for the case; if the time could not be cut down and if electricity could not be used.

The most rational way of cutting down the total running time for the trip would be the building of a tunnel underneath the bay, as has been proposed from time to time, and thus save the transfer of passengers to the boats and the comparatively slow boat ride. The most recent work of this character is the Pennsylvania railroad tunnels under the North River between New Jersey and New York, and for estimating purposes this type of tunnel will be used.

The "tube" consists of a cast iron shell lined inside with concrete. The outside diameter is 23 ft. and the inside 19 ft.; one tube accommodating one track. For a full description of this work see paper by Hewett and Brown, A. S. C. E., Vol. 36.

In order to make the submerged tube as short as possible the present Oakland pier should be used as far out as the filling would be allowed, the tube to start downward in the fill on say at 10 per cent slope and continue a few feet below the bottom of the bay across to San Francisco, due consideration being given to grades; if possible they should be kept under 1 per cent to avoid loss of power by breaking. In going through Goat Island the tube should

rise above the water-line in order to allow an ordinary tunnel to be substituted for the tube; omitting the cast iron shell. This cast iron shell is the most expensive piece of the whole construction, as it must be made much heavier than absolutely necessary for mechanical strength. The tube, 23 ft. outside diameter, in running through the silt displaces 415 cu. ft. per running ft. and as the weight of the silt is in the neighborhood of 100 lb. per cu. ft., the tube must weigh 41,500 lb. or more per running ft. in order to remain steady in its original location. After the weight of the inside lining, rails, electric ducts, etc., has been counted, there still remains about 12,000 lb. per running ft. to be provided for by the cast iron tube.

The west terminal station for suburban traffic if located under ground at the corner of Kearny and Market streets would be central and would permit of grades of less than one per cent for the last few hundred feet, where a much steeper grade would be economical to accelerate and retard trains.

The length of the tube below the water-line would be about 16,500 ft., the length of ordinary tunnel, through Goat Island and underneath Market street about 7000 ft.

Cost of one tube per foot 12,000 lbs. of cast iron segments with bolts @ 4 cents a lb. in place	$ 480
5 yards of concrete in place @ $10	50
Cost of boring below the water, per foot	30
Longitudinal reinforcing steel to guard against earthquake shocks and to make tube act like a girder, per foot	10
Rails, ties, etc	5
	$ 575
Engineering and incidentals, 15%	86
Total (per foot of tube)	$ 661
16,000 feet @ $661	$10,576,000
7,000 feet of ordinary tunnel and subway @ $160 per foot	1,120,000
Total for one tube (exclusive of electric installation)	$11,696,000

The total for two tubes will then amount to $23,392,000 + 1,000,000 for terminal station. Figuring 6 per cent interest on this cost and allowing 1 per cent for depreciation of structure the yearly cost due to these items will be $170,744 or about $470 per day. As this figure only covers part of the total expenses, in fact it represents the extra expense the company would have, if it changed over to tunnel generation from its present method. These extra expenses are so large as to prohibit the undertaking of tunneling underneath the bay under present conditions for any single railroad company entering San Francisco. If, however, all the railroads handling traffic on the bay could agree on one common project and each pay their proportional share, the project might be feasible at present. The advantage of the tube system over any other system that can be devised is of course apparent in the fact that the running time from the cities east of the bay to the business center of San Francisco can thereby be cut in half, an important item, although not so easily calculated in dollars and cents. As the boat service seems to be indispensible at the present time, the next question is, can electricity be substituted for steam on the boats and will it pay.

There are two ways of supplying electricity to motors driving ship propellers, one is by means of a storage battery and another by means of overhead feeders where this is possible. That a storage battery can be used on board a ferry-boat to drive the propellers is evident, but ordinarily it is not economical nor practical to do so and therefore, it is not used. The main reason why it is not practical to use storage batteries on board is that electricity costs too much at present and that the time the boat lays idle at each end of the trip is not long enough to recharge the battery at an economical rate. Twice the number of boats would be required to permit half of them to charge all the time, or else each boat would have to be provided with a much larger battery able to take a high charging current and resulting in a poor load factor besides being heavy and expensive.

In the course of the Key Route boats is an obstruction, Goat Island, preventing the boats from making the trip from landing to landing in a straight line. If this obstruction was eliminated it would serve a double purpose and make electrification of the Key Route boats feasible in the future, as shall now be shown. To eliminate this obstruction does not mean to remove the island, but it means a tunnel through the island big enough for the boats to sail through at full speed. The actual size of the tunnel required for this purpose is not so important to determine in order to get an estimate as to cost, as long as the rock is solid and lining or other supporting elements are not needed. From surface indications it can be taken for granted that the island consists of solid rock. Good crushed rock is worth more than $2 per yard delivered around the bay and it can be taken out of this big tunnel and crushed for less.

To make it possible to sail in a straight line between points of landing would require a tunnel about one-half mile long with approaches or about 1/6 of the total distance between landings. The most important feature of the tunnel is not that it makes the distance to be traveled shorter, but while going through this tunnel the battery can be charged from an overhead feeder system or a "third rail" and the motors draw current not from the battery but from the same system of feeders or from a separate system which furnishes current at 25 per cent lower voltage.

The battery receives energy instead of furnishing while the boat is traveling 1/6 the total distance. This is equivalent to 1/3 the total distance in case no means were at hand for recharging during the trip. If the ferry slips are also provided with a system of feeders in such a way that the charging can commence before the boat is actually at a standstill, the charging time can be made equal to the running time and no extra equipment is needed on account of having to charge the battery. The boat should be provided with four propellers operated by two independent shunt motors through Melville-Macalpine gears. The exciting current for the shunt should be regulated by cutting in and out cells and this operation accomplished from the pilot house. A rudder would not be absolutely necessary as the two motors could be made to run at different speeds corresponding to their field excitation; thus eliminating the effect of the tide current and ensuring

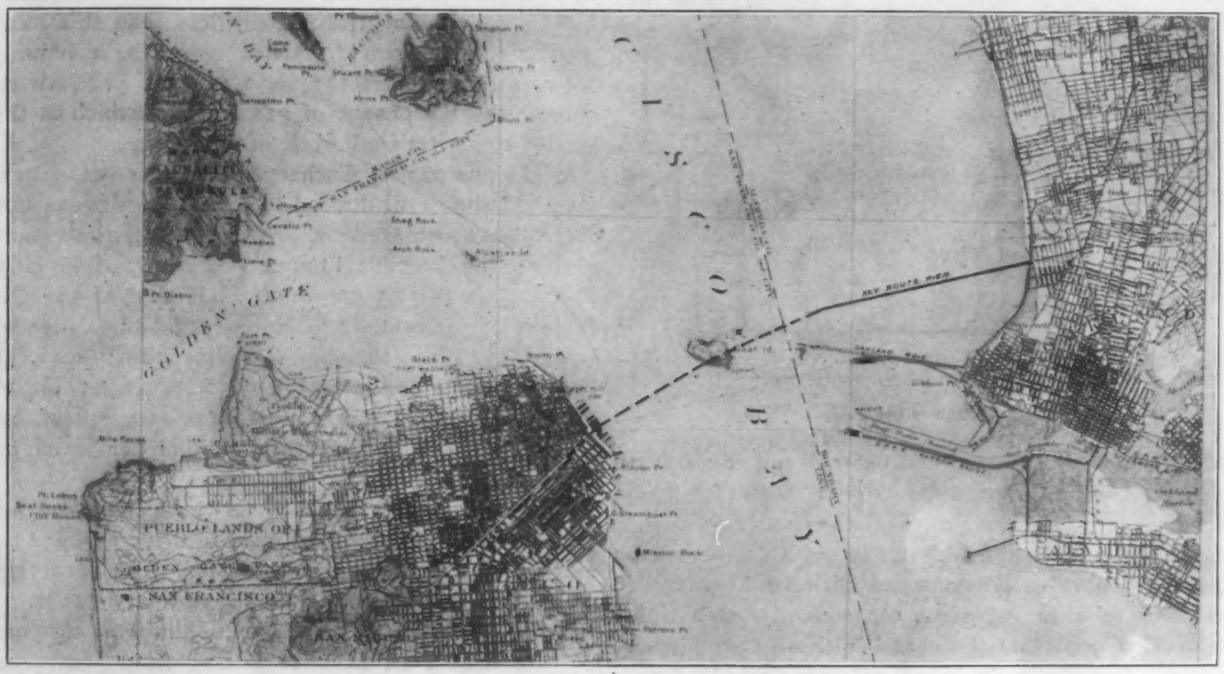
a smooth and straight landing, which in the case of having to commence charging the battery before stopping would be especially desirable. The operating voltage is supposed to be 500-600 volt. A sub-station would have to be built in the tunnel provided with rotary converter, transformers, etc., for feeding the boat while going through the tunnel and for feeding the San Francisco slip through submerged feeders.

At present the Key Route Company generates the electric power necessary for the generation of its railways by means of steam. Although the equipment seems to be efficient, the cost of generating a kw. hour must be in the neighborhood of 1¼ to 1½ cents per 24 hours and the cost of generating a h.p. hour on the boats more than one cent on account of the frequent stops. Should the boats be electrically driven and develop the same number of horsepower as the steam driven, we would have to supply quite a number of additional horsepower to make up for the electrical losses in motors, low tension transmission, rotary converters, transformers and battery with a total efficiency of $95 \times 90 \times 97 \times 98 \times 80 = 65\%$.

The two schemes, steam and electricity, will in this case be equal as far as power cost is concerned, if electricity can be bought from a transmission company for 0.65 cents per h.p. hour. The investment for an electrically driven boat is, however, larger than for a steam driven one, especially if we want to install more power, and to put the two propositions, steam versus electric driven boats on an equal basis, would necessitate a price of not more than ½-cent per electric horsepower hour.

Water-power plants can be built in California today for such an amount that power can be delivered and sold at a profit at ½-cent per h.p. hour in large quantities for a 20 to 24 hour load. As the industry progresses, this figure can possibly be cut down and as the cost of steam power is bound to increase in the future, it is evident that the use of electricity will spread into fields from which it is now excluded. From the above is seen that fuel needs to increase but little in price and water-power need to drop but little in price before the scheme of electrification of ferry boats in special cases is entirely justified from a financial standpoint.

As far as reliability of service is concerned electric motors are as reliable as steam engines and much cheaper to keep in repair. An electric storage battery charged is the surest thing on earth for power delivery. Should the long distance transmission fail for short intervals (preferably such a system should be connected to several power companys' lines) it would cause no interruption, the battery could simply be given an extra charge over night to make up for it. The size and weight of the battery would to a large extent depend upon the efficiency desired, that is, upon the rate of charge and discharge, upon which also maintenance charges depend. With a battery installation the center of gravity of the boat could be brought much lower, more space would be available for passengers and a larger power equipment could be put below the deck. As the motors should be controlled from the pilot house, one, or at the most two men, would be sufficient to look after the power equipment below and in this way compensation would be had for the somewhat larger investment in electric equipment. At present power companies do not sell and perhaps cannot sell power at ½-cent per horsepower hour or lower; therefore, until that time arrives much change in handling the traffic across the bay can not be expected, as it would not be economical to do so.



Map of San San Francisco Bay.

THE HUMPHREY PUMP.

H. A. Humphrey has invented a novel gas pump which is capable of many applications described in a paper he recently read before the Manchester (England) Association of Engineers. In the words of the author it is "a method of raising or forcing liquid which consists in applying the energy of expansion of an ignited combustible mixture to one end of a column of liquid so as to propel the column along a discharge pipe, and to cause it to oscillate in the pipe under such conditions of energy of the moving liquid, that everything necessary for preparing for the next ignition is performed during one or more oscillations, and wholly or partly owing to it or them."

Referring to Fig. 1 water is to be raised from supply tank S T to an elevated tank E T; C is the combustion chamber, W the water-valve box, V valves opening inwards, and D the discharge pipe. In the top of the

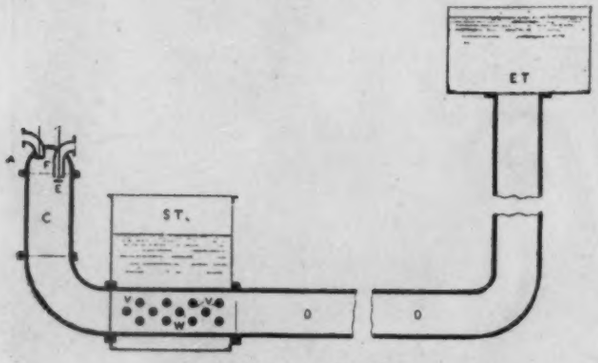


Fig. 1. Humphrey Gas Pump

combustion chamber is an inlet-valve A and an exhaust valve E. A simple interlocking gear is arranged between these two valves, so that when valve A opens and closes it locks itself shut and releases the valve E, and when valve E opens and closes it locks itself shut and releases valve A; consequently each time the suction occurs in the chamber these valves open in turn. Imagine a charge of gas and air to be compressed in the top of chamber C, and fired by a sparking plug which projects through the top casting. All the valves are shut when explosion occurs, and the increase in pressure drives the water downwards in the pump and sets the whole column of water in the discharge pipe in motion. The column of water attains kinetic energy while work is being done upon it by the expanding gases, so that when these gases reach atmospheric pressure the column of water may be moving with considerable velocity. The motion of this column of water cannot be suddenly arrested, hence the pressure in C tends to fall below that of the atmosphere, the exhaust valve E opens, and also the water valves V. Water rushes in through the water valves mostly to follow the moving column in pipe D, but partly to rise in chamber C in an effort to reach the same level inside the chamber as exists in the suction tank.

When the kinetic energy of the moving column has expended itself by forcing water into the high-level tank, it comes to rest, and there being nothing to prevent a return flow, the column starts to move back towards the pump, and gains velocity until the water reaches the level of the exhaust valve, which it shuts by impact. A certain quantity of burnt products is now imprisoned in the cushion space F, and the energy of the moving column is expended in compressing this gas cushion to a greater pressure than that due to the static head of the water in tank E T. Hence a second outward movement of the column results, and when the water reaches the level of valve E the pressure of the space F is again atmospheric, and further movement of the water opens valve A against a light spring and draws in a fresh charge of gas and air. If there were no friction the water would fall to the same level as that from which the last upward motion started, but the amount of combustible charge drawn in is slightly less than this movement would represent. Once more the column of water returns under the elevated tank pressure and compresses the charge of gas and air, which is then ignited to start a fresh cycle of operations.

The pumps may discharge into an air vessel, or an open stand-pipe, if desired to give a continuous flow.

With a compression pressure of 11 atmospheres absolute the theoretical thermal efficiency of the Humphrey cycle is 52.5 per cent, while that af the Otto cycle is 40 per cent. A compression of this order will be employed in a 1000-h.p. German pump; the author has only used pressures up to 50 lb. per sq. in., obtaining an actual efficiency of over 23 per cent, corresponding to 0.95 lb. anthracite coal per water h.p. hour on a lift of 35 ft.

A large scale experiment is to be tried in which a Humphrey pump will be used to drive a water turbine coupled to an electric generator. The advantages of such an arrangement over the ordinary gas engine arise chiefly from the simplicity of the working parts, the absence of all troubles arising from contraction and expansion due to heating and cooling, the freedom from cyclic irregularity, thus enabling alternators to be driven in parallel, and finally, the high efficiency and the low cost of upkeep. Also the apparatus may be started and stopped immediately, and can, indeed, be entirely controlled from a switchboard. One has to face the loss due to conversion of water-power into mechanical energy, but the efficiency of well-designed turbines can be guaranteed at over 80 per cent at full load, and in a central station there is no need to run any of the pumps at less than full load, since they can be so easily started and stopped. Moreover, if blast-furnace gas or producer-gas derived from cheap fuel is used, the loss of 20 per cent of the energy is not important, as compared with the advantages gained by the adoption of the gas-hydro-electric system, and the absence of the need for any lubrication would alone more than compensate for it. It is also proposed to apply the Humphrey pump to marine propulsion, and designs have been worked out for this purpose.

ELECTRICAL EQUIMENT OF THE LAS VEGAS SHOPS OF THE SAN PEDRO, LOS ANGELES AND SALT LAKE RAILROAD COMPANY.

BY JULIAN ADAMS.

The new shops at Las Vegas, Nevada, of the San Pedro, Los Angeles and Salt Lake Railroad Company at present consist of machine shop, blacksmith shop, boiler shop, transfer table, roundhouse and power-house. The buildings are of fireproof construction, being built of hollow concrete blocks and steel framework. A storeroom of similar design is under construction and the plans, when complete, will include a well-equipped mill and carpenter shop, it being intended to handle all the company's heavy repair work in these shops. A 100-ton crane travels the length of the machine and boiler shops, and an additional 10-ton crane is provided in the machine shop.

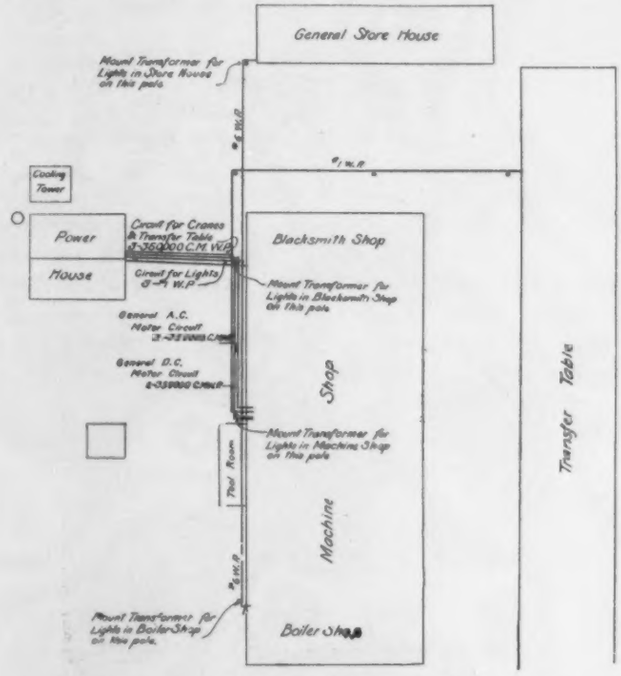

General Store House
Mount Transformer for Lights in Store House on this pole
Cooling Tower
Power House
Circuit for Cranes & Transfer Table
Circuit for Lights
Blacksmith Shop
Mount Transformer for Lights in Blacksmith Shop on this pole
General A.C. Motor Circuit
General D.C. Motor Circuit
Shop
Mount Transformer for Lights in Machine Shop on this pole
Tool Room
Machine
Transfer Table
Mount Transformer for Lights in Boiler Shop on this pole.
Boiler Shop

Fig. 1. General Layout of Motor and Light Circuits for Shops.

All the machine tools in machine, blacksmith and boiler shops are driven by individual direct connected motors, with the exception of a few of the small tools which are arranged for group drive. The individual drive was adopted in general in preference to group drive on account of the well-known advantages to be gained, which consist of: Increased output of machine tools; elimination of shafting and belting maintenance; increased light due to elimination of shafting and belting; the ability to operate a single machine at any time without the necessity of operating other machines; reduction in size of power plant required by reducing fractional losses; and saving in fuel due to reduction of frictional losses.

In deciding upon the type of electrical apparatus to be installed, the relative advantage of both alternating current and direct current systems were compared for the conditions to be met in these shops, having in view the ultimate addition of mill and carpenter shop. The final decision was in favor of a general alternating current system supplying alternating current for all constant speed machine tools, cranes, transfer table and lights, a motor generator set being installed to supply direct current for variable speed machine tools. The most important features governing the choice of the general alternating current system are the extremely low maintenance cost of alternating current equipment as compared with direct current equipment and the greater flexibility of the alternating current system for general light and power circuits in the shops. For variable speed machine tools, however, it was not considered that the present state of development of the variable speed a.c. motor warranted its adoption and d.c. motors were installed with field rheostatic control. The d.c. motors all operate at 230 volts, the a.c. motors at 440 volts, 3 phase, 60 cycles, and the a.c. lights at 110 volts. The following table gives the sizes and kinds of motors in the present equipment:

Tool.	Motor. A.C. H.P.	Motor. D.C. H.P.
90" Driving Wheel Lathe	5	50
90" Driving Wheel Press	10	
90" Quartering Machine		3
		3
44" Car Wheel Grinder	40	
36" Vertical Turret Boring Mill	9½	
36" Triple Geared Engine Lathe		10
24" Vertical Turret Boring Mill	5	
24" Engine Lathe		10
16" Portable Engine Lathe	3	
24" Turret Lathe		15
No. 4 Plain Miller	10	
36" x 16' Open Side Planer	20	
36" x 16' Open Side Planer	20	
32" Draw Cut Shaper		5
5' Universal Radical Drill	5	
30" Radial Drill	3	
24" Vertical Drill Press		7½
Multiple Drill, two spindle		7½
Multiple Drill, two spindle		7½
Multiple Drill, two spindle		6
	7½	6
51" Boring Mill	3½	
No. 2 Horizontal Boring Mill		5
18" Slotter		7½
1½" Triple Bolt Cutter	3	
3" Forging Machine	20	
1½" Forging Machine	10	
3" Horizontal Punch	7½	
60" Single Punch	10	
Rotary Bevel Shear	10	
Rotary Splitting Shear	7½	
6' Rolls	3½	
12" Rolls	20	
Flue Rattler	10	
Alligator Shear	15	
24" x 6¼" Turret Lathe		7½
No. 3 Single Punch	10	1
Blower	10	
Exhauster	15	
Group Drive	20	
Group Drive	20	
Group Drive	20	
	52	
	52	
100-ton Crane	22	
	30	
	52	
	22	
10-ton Crane	15	
	5	
Transfer Table	50	
Total	753	151½

Fig. 1 shows the general lay-out of motor and light circuits for the shops.

Fig. 2 shows a 60-in. single punch with a direct-connected 10-h.p. a.c. induction motor.

Fig. 3 shows a 90-in. driving-wheel lathe with a 50-h.p. d.c. variable speed direct-connected motor.

Fig. 4 shows the exterior of the power-house. The wall in the one end is temporary, to allow for future extensions.

The boiler equipment in the power-house consists three 250-h.-p. Stirling boilers operating at 150-pounds

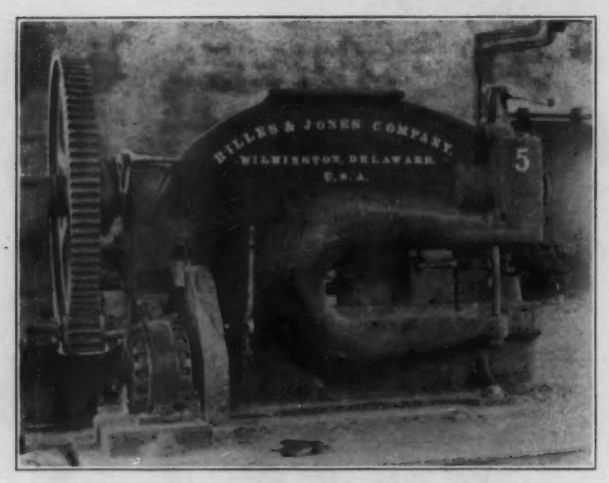


Fig. 2. 60 in. Punch With Direct-Connected 10 h.p. A.C. Induction Motor.

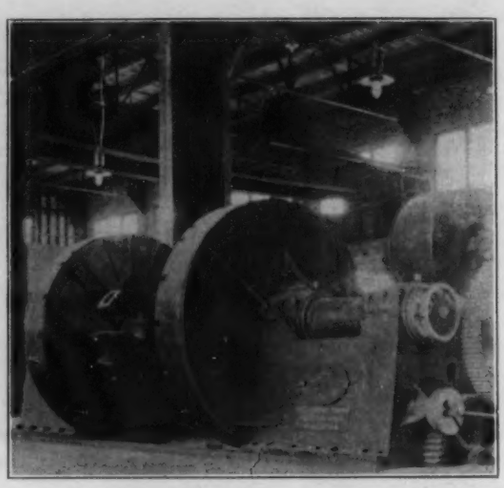


Fig. 3. Lathe With 90 in. Driving Wheel and 50 h.p. D.C. Variable Speed Motor Direct Connected.

pressure and 80 degrees Fahrenheit superheat. Oil is used for fuel and is pumped with a C. C. Moore fuel oil pumping system to the Hammel burners used in the boilers.

The generating equipment consists of two Allis-Chalmers 300-h.p. horizontal cross-compound condensing Corliss engines, direct connected to two Allis-Chalmers 200-kw., 440-volt, 3-phase, 60-cycle, 150-r.p.m. generators with belt-driven exciters. A 100-kw., 440-volt a.c. to 230 d.c. synchronous motor-generator set furnishes direct current. This motor-generator set is self-exciting and is not provided with any starting equipment. It is thrown on the line before the engines are started and is gradually brought up to speed as an induction motor as the engines are brought up to speed.

The switchboard consists of seven panels with General Electric switchboard instruments. There are two generator panels, one a.c. and one d.c. panel for the motor generator set, and three a.c. feeder panels, one of which controls the circuit for cranes and transfer table, one the lighting circuit and the other the general a.c. motor circuit for machine, blacksmith and boiler shops.

Fig. 5 shows the wiring diagram for the power house.

Besides the generating equipment the engine room contains one 1600 cu. ft. per min. Ingersoll-Rand cross-compound, condensing air compressor, full load speed being 150 r.p.m., and the air pressure being 100 pounds.

The condensing equipment for each Allis-Chalmers engine consists of one C. H. Wheeler surface condenser having 570 sq. ft. of cooling surface, together with one 6 in. x 4¾ in. x 12 in. Pratt patented Rotrex vacuum pump and one 5 in. centrifugal circulating pump both

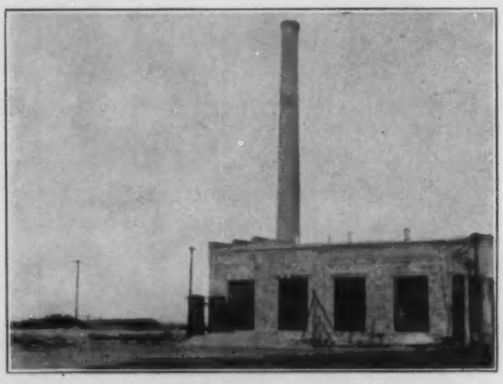


Fig. 4. Exterior of Power House.

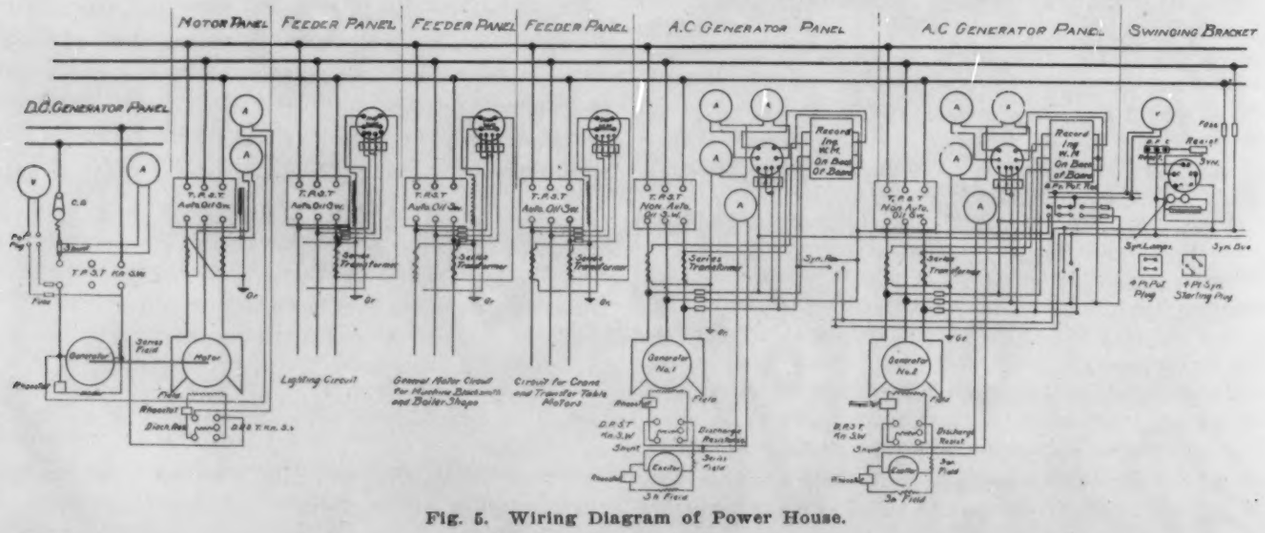


Fig. 5. Wiring Diagram of Power House.

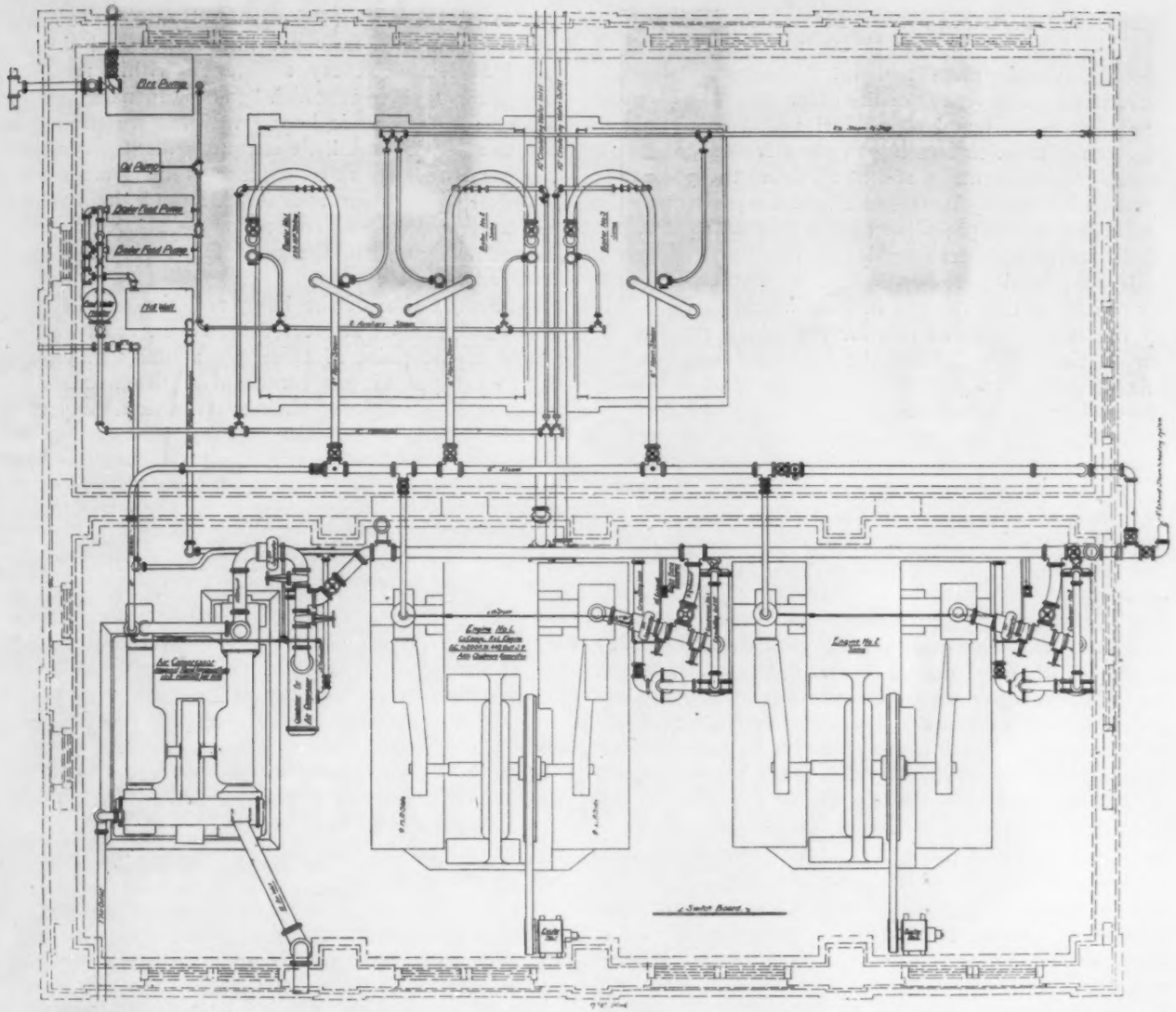


Fig. 6. General Piping Layout of Power House.

direct connected to one 5 in. x 5 in. vertical high speed engine. A Knowles Worthington surface condenser is used in connection with the Ingersoll-Rand air compressor. In the case of all three units a Cochrane vacuum oil separator is installed between engine exhaust and condenser.

The boiler feed water pumps consist of two Worthington compound outside center packed 6 in. x 9. in. x 4½ in. x 6 in. pumps.

The exhaust steam from these pumps and from the condenser air and circulating pumps is used for heating feed water in a Goupert feed water heater.

All condensation from high pressure piping system and water separators is returned to the boiler by means of a Crane direct return trap. All condensation from receivers and exhaust piping is returned to the hot well by an automatic return pump.

Fig. 6 shows the plan of the general piping lay out of the poper house.

The limited amount of water available made it necessary to construct a cooling tower for use in connection with the circulating water for the condensers.

DAM DESTRUCTION BY GROUND SQUIRRELS

Ground squirrels have a habit of burrowing in embankments. In the flat country they seek small elevations from which they can better observe the approach of their enemies. Dikes, levees, roadways and embankments of all kinds attract them and are often seriously undermined by their burrows. In the irrigated districts their underground tunnels, like those of the pocket gophers, frequently cause breaks costing large sums to repair. Thus in May, 1910, ground squirrel burrows caused such a serious washout in the Turlock Canal in Stanislaus County, California, that the line of the canal had to be changed at a cost of $25,000. The break occurred during the latter half of May, and the labor of rebuilding the waterway occupied about three months, depriving the ranchmen of water at the very time it was most needed for the irrigation of their alfalfa and other products and entailing a loss of upward of half a million dollars.

THE INTRODUCTION OF THE GAS FURNACE.[1]

BY CHAS. F. STAMPS.

The development and introduction of the gas furnace as a competitor of the older styles of furnaces using wood, coal and oil as fuel affords material for one of the most interesting of chapters on gas appliances. In all countries and at all times the prevailing systems of heating have conformed necessarily to the conditions which prevailed at the time and place. In those sections where wood and coal were plentiful and cheap, and gas was high, it followed, as a matter of course, that the gas furnace would be used only by the few who cared less for the added expense incurred than they did for the increased comfort obtained and greatly reduced trouble and attention required in its operation.

With the discovery of natural gas, however, and its remarkable cheapness, immediate attention was called to the possibilities of its use in the localities supplied, as a fuel within the reach of all, and the rapid introduction of appliances for its use in cooking, heating and manufacturing followed. The very abundance and cheapness, however, of the natural gas in these favored sections seems to have operated to defer the invention of a gas furnace worthy of the name, for the good reason that economy was uncalled for, and there was no need to trouble one's self about the invention of a furnace constructed on scientific principles, as long as a flat rate of one, two or three dollars per month could be obtained for unlimited service. Thus for a time the crudest of appliances filled the requirements of the users and if the supply of cheap gas had held out undoubtedly there would have been a continuance of the slack methods of its use. But lessons were being learned. Time is money and comfort is worth paying for. The saving of time and labor, the cleanliness and ease with which the volume of heat could be controlled and regulated, appealed to the judgment of every customer and the public mind was educated to the real need for gas as a fuel for all domestic purposes.

The discovery of oil in California, followed by the invention of methods for its use in the making of gas in abundance, and at a price "within the reach of all" brought the opportunity to our door here in sunny California, where the high prices of coal and wood as well as the climatic conditions combine to make it the ideal country in which to make use of the advantages which the gas furnace most undoubtedly possesses over all other types of heating systems.

Quite naturally then, we have here a prolific field calling for invention and, true to the law governing demand and supply, we find the answers coming from many quarters. For the past seven years particularly there has been especial activity in this line, and the evolution of the gas furnace from the first crude efforts of that date to the types now being turned out affords an interesting study. Sufficient advance has been made to command the attention, and it is safe to add also, we think, the respect of the most conservative gas officials, who, for several no doubt very good reasons, have been slow heretofore in lending their endorsement. Now, however, with increased facilities for supplying gas in large quantities and at a price within reach of the general public, the opportunity becomes of immense importance and the propriety of lending every assistance within reason in the matter of rates at which "gas for furnace heating" can be supplied, it is hoped will receive their most serious attention. A little encouragement given along this line of reduced rate on gas used in furnaces would doubtless greatly increase its use, and the company that first proffers the concession would receive from the public in return, the good will and patronage it deserved.

The question of the hour, and the one in which this association is interested, however, resolves itself briefly to the point of efficiency actually attained in the best types of gas furnaces on the market, and the general principles of their construction, etc. Without mentioning any special furnace or its manufacturers it is sufficient to say that the gas furnace has established for itself a record of efficiency and merit which entitles it to our confidence. The difficulties met in the earlier efforts have been largely overcome and improved methods of construction have at last given us a product that it is confidently believed will stand the test of time and use. To attempt a description of the many types of furnaces brought out to date, would be out of the question in an article as limited as this must necessarily be, suffice is to say that experience has proven unquestionably a few things at least, among which are the following, viz:

(a) That the successful gas furnace must be provided with a vent by means of which all impurities of combustion can be carried off.

(b) That the vent should be taken from the bottom of the furnace.

(c) That the first essential is perfect burners, and of not too large size.

(d) An increase of the radiating capacity to the highest degree possible.

(e) A method of construction permitting the taking apart of the furnace for the purpose of cleaning it by removing the products of condensation.

(f) A method of construction and above all a manner of installation in every case, that will allow the freest possible passage of the air to be heated, through the furnace, consistent with the heating capacity of the furnace.

A careful study of these principles and comparison of the different methods of construction employed will be a valuable help either in the development of a new furnace or in making a selection of the best from among those already on the market. Undoubtedly there will be more or less important improvements made in the days to come but enough has been already achieved to place the gas furnace along side of the gas range and water heater as an assured success, and we predict for it a future limited only by the available supply of gas and the price at which it can be delivered to the consumer.

A conservative estimate of the total number of gas furnaces installed thus far in Southern California, including all the different makes, numbering at least nine of local manufacture and one from the East, would probably not fall short of eight hundred, the most of which have been put into use during the past two years.

[1] Paper Read at Eighteenth Convention Pacific Coast Gas Association.

DISCUSSION AT EIGHTEENTH ANNUAL CONVENTION, PACIFIC COAST GAS ASSOCIATION.

The Introduction of the Gas Furnace.

Mr. Basford: I have had some experience with the gas furnace. If every maker of gas furnaces would study the rudimentary elements of the subject of gas heating, and endeavor to get the best out of them, with reference to the radiating surface, but more than all the top of the burner, that would be an easy question to answer. The trouble with the majority of makers of gas furnaces, is that they have the same ideas as they had ten years ago. They think all you have to do to get a gas furnace, is to put a flame under a drum; that is the meaning of a gas furnace in simple terms. That all you have to do to get acetylene, is to add water to calcium carbide; but there is a vast difference between the elements and the operation of a machine. Now then, I believe that there is no other one device, that has been such an enemy to the gas companies, as the gas furnace. Not because it is called a gas furnace, but because of the class of furnaces they are manufacturing. They are certainly poor, some of them. I believe it is up to the gas companies to investigate every gas furnace on the market, and unless it has the reasonable application of scientific principles of operation, they should frown upon it, because it is taking money out of their pockets. This is an expression that I frequently hear: "You will please excuse me, I wouldn't use a gas furnace. It costs more than anything else in the world to run, and in two years' time you have to get a new one." Answering the last question, in regard to the use of wood and coal as compared with gas. Coal is the cheaper fuel. However, if the gas furnace is used intelligently, if the manufacturer would instruct his people in the use of them for the first winter at least, you will find that there will be a marked improvement in the situation. You know that gas burns until you put it out, but coal goes out. I think that the people should be instructed by the companies and given a fair knowledge of the use of gas furnaces, and in that way the companies should supervise the installation of furnaces they put on the market.

Mr. Berkley: We had occasion last winter to make some experiments as to the cost of heating bungalows and small houses. By an arrangement we put in two meters in some houses with the understanding that we would remove one of them as soon as the demonstrations were over. I do not know the make of the furnaces used, but I do know that the people were greatly satisfied with them. The cost of operation was not exorbitant. I advocate gas furnaces, but if we could make some improvements on them as to economy, we would have a great deal more business than we now have. I believe we should assist the gas furnace builder; it is not a hard or unsurmountable problem, but being a physical proposition it can be solved within a reasonable time so that we all can heat our houses with gas profitably. I contemplate using gas this winter instead of solid fuel; I find it is as cheap, for with coal at $12.00 per ton and wood at $9.00 per cord, there is economy in its use. The comparison just drawn does not compare for the fact we are all more or less negligent with the use of solid fuel; having been brought up in its use where there was no restriction on the amount of fuel we used when farmers' boys. Now, when we buy fuel by the hundred feet it becomes a different matter. I think today we have a great opening for the sale of gas to be used in gas furnaces, for sunny California needs heat, as any Easterner will attest. I think we ought to start some concerted plan of action in regard to gas furnaces; it will bring the greatest returns.

Thaddeus Lowe: Being interested in a company manufacturning gas furnaces and stoves, I can hardly sit still and hear the statements which have been made, without having something to say. What the gentlemen did say was true to a certain degree today. That is that the construction of a gas furnace does not take into consideration its economy. Being more or less in the gas business ever since I was born, I realize the fact that to increase the use of gas and keep the people satisfied, you must give them plants that are economical, and we have been experimenting along those lines for a number of years past, and we believe today, that we have as perfect a gas furnace as it is possible to obtain. I wish to say in regard to our gas furnace that we have a great many in use. One of them has been in use for at least seven years, and it is in use today, and the bills compare favorably with the bills of any other fuel. We all know, of course, that gas flows easily, and it is a whole lot easier to let it flow than it is to step down stairs and turn it off. I do want to say that if there was a little attention given to it, that the average person would not do away with it. It is too great a convenience. It does away with wood, and coal and the care of looking after them, as well as dirt and ashes. We have placed twenty-five or thirty furnaces and we have now about twenty orders and all these orders were obtained upon the recommendation of people using them during the last two or three years. We have a furnace heating the Episcopal Church in Pasadena, and during Lent, when they were having service practically every night, the bill for one month was $23.00. The inside height of the church is thirty-nine feet; it is constructed of granite and brick, and has a cement floor. The temperature ranged anywhere from freezing up to 50 degrees about that time. It was the coldest month in the winter.

Mr. Lenkfeld: I would like to say a few words in regard to the gas radiators. Mr. Lowe said he had some on exhibition in the building, and invited us to look at them. I have taken the privilege of doing so, and I cannot find any improvements on Mr. Lowe's radiator, over the ones which I used for years and years past. Now if I am wrong in my estimation of getting heating units out of gas, I stand corrected. But I want to say that we all know that the gas range would only give about 75 per cent of the heat, which is obtained from the gas range without a gas furnace. We would have 100 per cent with an air mixture. There should be a way of getting a gas and air mixture in a gas radiator or gas heater. Now what is best with a range is best with any other heating device. I feel sure that if we shut off the air mixture from the gas range, that the gas range will not give any satisfaction at all. It will not get the heat units out of it, as it will with the air mixture. I would like to see a trial made of that.

L. P. Lowe: I am not the Lowe who has anything to do with the heater down stairs, but in the absence of my brother, I will do what I can to reply to Mr. Lenkfeld. In the first place, it should be definitely understood, by everyone in the gas business, that you cannot increase the heat in gas. That is physically impossible. If a cubic foot of gas contains 650 British thermal units, you have no more, no less. All you can do is apply the heat differently. If you burn that gas in a yellow flame, as we do when we use it for lighting purposes in an open flame burner, you get just as much heat as when mixed with air; the only thing accomplished by burning it with a mixture of air is to consume it in a smaller space. There is no gas heater in the world better than any other heater, so far as the actual development of heat is concerned, the only difference being in its application. The principle point is to use as much as possible of the heat. If you allow all the products of combustion to escape in a room, without taking any off through a flue, you will get every unit of heat in the gas, provided you consume all that gas, no matter what kind may be the heater. Because of the presence of sulphur compounds it is not well to allow the products of combustion to escape in a room in any large quantity. It may be well enough to heat a bath room in that manner, but to allow the products of combustion to escape in a room from a heater burning 40 or 50 feet of gas per hour, would be bad practice. The sulphur in gas, in combination with the water, due to combustion, forms sulphurous acid, which is ruinous to fabrics, pictures, frames, furniture, and other articles.

It is, therefore, necessary, in burning gas in large quantities, to allow a little heat to escape in a flue in such a manner as to create a draft in order to carry off the products of combustion. A heater must also be so constructed that it can be kept warm throughout while in operation. If it is not so kept, the condensing products of combustion will form sulphurous acid which will destroy the metal of the heater; therefore the crucial point in the construction of any heater is to design one that will extract all the heat, save only enough escaping in the flue to create a draft to carry away the products of combustion. A heater may be so constructed as to extract all the heat from the gas before it reaches the flue, and if so you will have no draft, and such a heater would be faulty, though you might create an artificial draft, as they do in England, by burning a jet of gas in the flue and so get just enough heat to carry away the products of combustion.

Chemical Control of Gas Manufacture.

Mr. Jones: Gentlemen—In my opinion Mr. Hall has presented as good, if not the best technical paper, that has ever been presented to the Pacific Coast Gas Association. It is full of good common sense, and every statement he has made in it, is backed by a good reason. We certainly ought to extend a vote of thanks to Mr. Hall, for the time devoted to the preparation of this paper. I would like to ask Mr. Hall one or two questions. In the washing of gas with oil, you mention that you heat your oil to a temperature of 130 degrees Fahrenheit How do you maintain that temperature?

Mr. Hall: In regard to keeping the oil at that temperature, we have on the bottom of the pump, a heating chamber, which is furnished with steam from the pump itself, so that the faster the pump runs, the more exhaust steam is sent into the oil supply.

Mr. Jones: Between the vapor tension of napthalene vapor, and the vapor of the more stable illuminants, the hot oil affects one, whereas it does not affect the other.

Mr. Hall: We didn't go into the difference of the various hydro-carbons, because we have had no loss of candle-power.

Mr. Jones: Have you determined what takes place if the heat of the oil is more than 130 degrees Fahrenheit? How do you determine the desirable temperature?

Mr. Hall: We have found that that temperature is the one which would take out practically the least amount of napthalene, and yet not injure the candle-power.

Mr. Wade: In regard to this fire brick question, which has just come up, I might say that I have analyzed one sample of the brick made in Los Angeles, and I find the per cent of iron is considerably less than mentioned by Mr. Hall. I don't remember the exact analysis; but it was less than 3 per cent. There is one point about oil I would like to bring out, and that is that gas men should buy oil on the heat unit basis, and not by the gallon, car load or ton, but buy it by so many heat units. You cannot use oil that is too heavy on account of physical reasons and not chemical reason.

Mr. Lowe: As a matter of fact, the information relative to the accurate test of water in oil is not nearly of so much commercial value as scientific, by reason of the fact that the oil companies set forth in their contracts the method we shall use in determining the water. If we use more accurate methods and attempt to deduct for water from our bills, the deductions will not be allowed. We must test in accordance with the terms of the contract, and if we use greater refinements, they will charge more for the oil. Therefore, the discussion on this point is of greater technical value than commercial.

As to Mr. Hall's paper, it is manifestly impossible to discuss an effort of its excellence in a convention of this kind. It is one of the most valuable of the contributions to the literature of this Association.

Mr. Lowe: The reason that this paper is particularly interesting to me at this time, and likewise to the other gas companies making and delivering it in the City of Los Angeles, is because of the enforced conditions under which the city gas inspector is compelled to make his tests. Mr. Schade, as I understand it, is making a daily calometeric test of the gas furnished by the three companies, and from that calometeric test he determines the photometeric value of the gas by multiplying of factor of three; that is to say, that if a gas contains 600 B.t.u. by the calometeric test he assumes that gas to be 18 c.p. on the general assumption that 100 B.t.u. represent 3 c.p. of gas. Mr. Hall's determination shows that Mr. Schade, in adopting this method, is giving those of us delivering gas in the City of Los Angeles, too low a photometeric value, as Mr. Hall's determination shows that a gas of 600 B.t.u., instead of having 18 c.p., would be really about 19. I don't know whether any of the rest of you are attempting to estimate your values in that manner, but if so I especially recommend this chart for your consideration.

Mr. Schade: I didn't want to speak on this subject, gentlemen, because I have taken up considerable time on other questions, but since my name was mentioned, I will admit that the statement is correct. I am a hard worked man; I have more work than I really can do, because I do a great deal of work that does not belong to my office at all, but I am working for the benefit of all the people of the City of Los Angeles. However, I will say that I have to minimize my work as much as possible, and therefore I have to adopt time saving methods. That is the reason why I use the factor of 3 to multiply the heat units, a test which is practically correct. I don't know what others use, but I used to use the old regular candle test, but have discarded it and replaced it in my photometer, with Elliot's kerosene lamp, because the candle test was unsatisfactory, on account of the fact that frequently the candle would burn more rapidly on one side than the other, almost cutting a channel along the side of it, destroying the accuracy of the test and naturally the candle would have to be thrown away and the work done over. Besides the cost which is twenty cents per candle, amounting to $120 a year, is much greater than by the use of Elliot's photometer lamp, where less than ten gallons of the best kerosene will do the work, amounting to but $3 per year. It is a well known fact that 32 heat units of carburated water gas will carry 1 candle-power, while of crude oil water gas, 32 heat units are required to carry 1 candle-power.

Mr. Jones: I have known a calometeric test of non-luminous coal gas which showed 750 B.t.u. Natural gases have from 650 B.t.u. to over 1000 and they are non-luminous; therefore I don't see how you can multiply heat units by a factor to arrive at the candle-power of a gas.

Mr. Schade: He is absolutely correct, but I handle gas manufactured here, and it holds good as to gas manufactured in this city and practically on the Pacific Coast.

Mr. Britton: For the benefit of a good many gas men who are not chemists, I would like to ask Mr. Hall to give an explanation of what transformation takes place by oil washing in the naphthalene vapors that occur in the gas, prior to the gas washing.

Mr. Hall: We need a high compression to clean them of their naphthalene and benzine vapors, that is throw down the benzine and naphthalene substances leaving a residium, the gas being carried forward to the purifiers. Gas can be deprived of its illuminating power, that is practically, by compression, but it can be restored to life again by the absorption of benzol vapors.

Mr. Britton: Have you a theory to advance on the question of absorption by naphthalene vapors by the oil, heated at a temperature of 130 degrees; that is taken up in another form, from the gases passing through that body of hot oil?

Mr. Hall: I will say that naphthalene after being dissolved passes more into the solid. The transformation of naphthalene in vapor does not pass through liquid form, and when they receive it, it is a hydro-carbon in a class by itself, and with the other hydro-carbons, the vapor tension is such that the oil at that temperature will not carry them into a solution, while at that temperature, naphthalene is carried into a solution.

THE PROBLEM OF TECHNICAL EDUCATION.[1]

BY P. PETROVSKY.

From the contents of the paper and the character of the discussion it would seem to be the general opinion that the present system of technical education does not work well, and that there is something wrong with it. These conclusions are based on the fact that many college graduates do not succeed in actual engineering work, and that employers are not satisfied with the work of college graduates.

I leave entirely aside the subject of developing the character, and confine myself to the question of technical education proper, or in other words, the supplying to graduates the necessary amount of knowledge. A thorough mastery of the engineering sciences is not possible to everybody. The young man desiring to devote himself to the engineering profession must have some inborn capacity. At the present time many young men go to engineering colleges solely because they expect thereby to receive larger salaries, but some of them have no ability in engineering, and since in college they are not separated from the more able men they sooner or later graduate, and after graduation as a natural sequence start in actual engineering work, with the result that they are failures.

The man with an inborn technical character of mind, whether he has a college education or not, will love his work, not because it pays, but because in technical progress he witnesses the display of human genius and is proud to himself take an active part in the development of new methods. No amount of education can develop these necessary qualities in a man who is not born with them. Therefore the admission to college and the taking of courses should be arranged in such a manner as to prevent incapable men from graduating.

There prevails an opinion among students that the work of the engineering colleges is difficult. This is really not the case. The student has perhaps to spend more time in the laboratories, in working out problems, writing reports and drawing diagrams than the students in the general courses, but there is no real difficulty in the work of the engineering courses. Anybody can fulfill the requirements and be graduated, provided he is willing to sacrifice enough of his time.

The work done in college is not such as to make the students think. This is the main evil of the system. A great deal of the required work is purely mechanical and consists in obtaining a result by the use of ready-made formulae. Of course engineering graduates should know how to use handbooks and formulae, but this knowledge is only a little part of what they should know. The methods used in actual practice are often different from those taught in class, and only a small part of the so-called "practical" knowledge obtained in college can be applied in practical life. This, therefore, can not be the main aim of education. Knowledge of general principles, a thorough understanding why formulae are as they are and not different, in fact, the true philosophy of engineering, all these are needed as a proper preparation for the engineering profession.

Under the present system, if a student meets a theoretical difficulty he feels that it is not necessary for him to busy himself and overcome it. He knows that the formulae is given and he knows how to use it, and he believes this to be sufficient, but one might just as well explain the use of many formulae to an intelligent skilled laborer, expecting that he may as a result become an engineer. Since the present system does not test the reasoning power of the students they have no incentive to put stress on brain work and to spend their time in thinking.

All this means that the work of our engineering colleges must be made "really" difficult. The work done by any student in a good college must of necessity be difficult.

I would suggest three principal reforms in technical education.

1. Increase the entrance requirements in mathematics and establish good, strict mathematical courses for the first three years residence of the student. Mathematics is the foundation of every kind of engineering, and is absolutely indispensable. No amount of mathematics can be superfluous. Theory of functions and partial differential equations are just as necessary as high school algebra. A careful test of mathematical ability should be made during the first year, and all who fail to fulfill the requirements should be advised to drop engineering work and go into some other course or college. Of course this means an increase in the difficulties to be overcome by the students, but this is as it should be, because mastery of the engineering sciences cannot be made easy. The student should appreciate beforehand that the task is difficult and the goal not accessible for everybody.

2. The present system of early specialization must be abolished.

The engineer must know very well all branches of engineering, and he must know some one perfectly. This perfect knowledge of his specialty he can obtain only in actual practice. The college does not propose to make engineers, and nobody expects new graduates to be engineers at once, but the college must prepare the graduate for the possibility of such development. Under the present system a graduate in civil engineering knows nothing about electrical engineering, and a graduate in mechanical engineering knows very little about civil engineering, but true and real "engineering" is more universal than this, and progress in one line of engineering is possible only with progress in all other lines. If engineering graduates are to work not only for the salary for themselves and the profit of their employers, but are also to work for the progress of technical science. they must be broadly educated in all lines of engineering. Until this change is brought about America will lag behind Europe in scientific engineering.

3. Introduction of oral examinations. Under the present system of final examinations about 25 per cent of the term is wasted, and these final examinations add nothing to the knowledge of the students. They do not even furnish a reliable test of their scholarship. In place of these final examinations the student should be given every three or four weeks oral class examinations.

In order to hit a bull's-eye it is necessary to aim slightly above the center of the target, and similarly in order to acquire the proper amount of knowledge we must strive to be able to impart our knowledge to others. At the oral examination it is impossible for the student to dodge some difficult theoretical point. He must overcome it in his preparation, because he knows he will be summoned to the blackboard to explain this theoretical point to the class.

The probable objection to the reforms above indicated which may be urged is that it is impossible to increase the amount of work which can be accomplished by the students, but in reply I would say that many of the problems, reports and drawings required at the present may be well omitted without any loss whatsoever. Work at home should consist primarily of reading and thinking. A limited number of problems individually assigned to each student might be given during the term. With such conditions of instruction in vogue the number of lecture units might well be increased 50 per cent, which system is practically that in use in European technical and scientific universities at the present time. The introduction of such changes would result in giving the graduates really valuable theoretical preparation for their profession.

It is quite possible that such a system will greatly reduce the number of engineering graduates, but the result will be better, because the smaller number of graduates will give a much larger percentage of successful engineers.

[1] Communicated Discussion on Paper by S. B. Charters Jr. and W. A. Hillebrand.

POWER FACTOR CORRECTION.[1]

BY L. S. ODELL.

In these days a.c. power systems are becoming so common, and the attendant problems in power factor correction so well understood, that to those familiar with the subject, any further discussion of power factor correction by the use of the synchronous motor must seem superfluous. However, recent installations of these power systems has to some extent revived interest in an old subject, as is manifested by the inquiries received by manufacturers of electrical apparatus regarding the synchronous motor, its adaptability to the correction of power factor on systems already installed and the size and design of the motor required.

Whenever power is used from an a.c. line, whether it be through the medium of synchronous or induction motors or by means of a transformer, as is the case for lighting purposes, it is always found that the reading of the wattmeter, showing the power used, is less than the product of volts and amperes on the line. The percentage that the former is of the latter is the power factor. The energy component of the power carried by a line is the volt amperes x power factor. We have also to consider a wattless power component displaced 90 degrees in phase from the energy component, so that $P.F.^2+W.F.^2=1$ where W.F. is the factor, by which we multiply the volt amperes to give the wattless power component. In a power system these wattless power components are not registered on the customer's meter, nor do they directly necessitate any increase in power at the generating station. However, a low power factor on a system means that a current much greater than that required for real power consumption is being carried, necessitating greater line capacity, larger machines, etc., and increasing the losses due to inductance, capacity losses, friction, etc. On a light load these losses may become very large, compared with the load, giving a system of low efficiency.

Induction motors, when working, cause a lagging current. Transformers also constitute an inductive load, and create a lagging wattless component of power, but when used in connection with a lamp load, the reduction of power factor is not so serious. Now the wattless component of a synchronous motor, under certain conditions, leads the power component, so it is at once evident that synchronous and induction motors might be worked together on a system in such a way as to make the leading and lagging effects neutralize and create a power factor of practically unity.

Induction motors are the more common type in use for general purpose work, so that usually a synchronous motor, when put in, is employed to correct a loss power factor due to lagging currents caused by the former type of motors. Suppose this power factor is .8. Experiment shows that as the power factor is corrected more and more nearly to unity, the capacity of the synchronous motor required to make a further change becomes relatively much greater as, for example, if a motor of 100 k.v.a capacity were required to correct the power factor from .8 to .95, one of 200 k.v.a. capacity would probably be required to bring it up to unity. Hence it is not consistent with economy in first cost to install a motor large enough to completely correct the power factor of a system, as the last few per cent of correction are dearly paid for in the increased k.v.a. capacity required in the motor. The better practice is to install a motor large enough to bring the power factor to .90 or .95 when the system is fully loaded, while on light loads the capacity of the motor will be sufficient to raise the power factor still higher, and perhaps completely correct it.

The synchronous motor will do its work as a corrector of the power factor whether coupled to an external mechanical load or not. However, it is advisable to put it on such an external load if possible. Such a load will be represented in the motor by a power component in quadrature with the current used for power factor correction, giving a resultant load not much in excess of the correction load even with a considerable mechanical output. For example, in one case it was found that an external load, equal to 50 per cent of the correction load, could be carried with an increase in the required k.v.a. capacity of the motor of only 12 per cent.

The following example will serve to further illustrate the circumstances under which a synchronous motor may be installed. Suppose induction motors are now carrying a load of 800 kw., with a power factor of .8. It is desired to determine the capacity of a motor of the former type which will correct the power factor to .95 and carry a load of 200 kw.

Wattless current due to induction motor load at .8 power factor, $\sqrt{1-.8^2}\times{}^1/_{.8}\times 800=600$ k.v.a.

Total wattless current due to load of 1,000 kw. at .95 power factor $=\sqrt{1-.95^2}\times{}^1/_{.95}\times 1{,}000=336$ k.v.a.

Hence the synchronous motor must furish the difference between these two results, the former being the initial lagging component and the latter the lagging component after correction. Combining this difference of 264 k.v.a. with the machanical load of 200 k.v.a. in quadrature we have:

$\sqrt{264^2+200^2}=332$ k.v.a.=total capacity of the synchronous motor.

Then the power factor at which the synchronous motor will operate as $\frac{200}{332}=.6$ approximately.

Hence in above case a synchronous motor of 332 k.v.a. capacity must be installed, and the excitation so controlled that it will operate under a power factor of .6.

The reason for this adjustment of excitation is as follows: Such a motor when operating under any particular impressed voltage, sustains a constant magnetic flux, no matter what the exciting current may be. A lagging or leading induced armature current is set up, this induced current being such as, when combined with the field excitation, will give a constant magnetizing force. When the fields are over excited a leading current will flow in the armature, and hence a synchronous motor must always be over excited when used to correct a power factor which is held down by lagging currents. When operating a synchronous motor, as explained above, an increase in the field excitation

[1]Applied Science.

will increase the leading current it will draw from the line, while decreasing the field excitation will decrease this leading current until when this leading current falls to zero the motor is operating under unity power factor. A further decrease in excitation would cause the machine to draw a lagging current from the line, so that if necessary a synchronous motor could be used to correct power factors for either leading or lagging currents.

Certain important characteristics effect the suitability of a motor for this class of work. Any a.c. generator would operate as a synchronous motor, but used for correction of power factors held down by lagging currents, might not be satisfactory. These machines are over excited, and the excitation increases directly as the current, while the heating effects in the field coils increase as the square of the current. Hence machines of low frequency where the number of poles is small and which often give trouble by heating when used as generators, will not do, owing to the high temperature in the fields. A machine with a small air gap decreases the amount of excitation necessary. Also the weaker the armature, or in other words, the fewer the coils in it, and the lower the resistance of those coils, the greater will be the induced leading current for the same increase in field excitation. Hence the characteristics of a good machine for power factor correction are a large number of low resistance fields, a small air gap and a weak armature. Such a machine, however, is not likely to be satisfactory as a generator.

Throughout the country there are a great many induction motors operating on power factors of from .5 to .7, and in many cases power consumers are being penalized by the companies, who insist on a power factor of .9 to secure the lowest rates. The synchronous motor offers a means of correction of this difficulty. In many cases, however, the saving will not justify the expense entailed, especially where there is the employment of skilled labor to be reckoned on along with the installation. In other cases, where the load is taken off at only a short distance from the generator, the initial expense is again prohibitive, as the increased generator capacity is the only saving effected. However, on long transmission lines where a low power factor necessitates increased capacity of generators, step up and step down transformers and all other apparatus in the system there is no question as to the advisability of using some means to balance up the lagging and leading currents and hold the power factor as near unity as possible.

ELECTRIFICATION OF KONGO RAILWAY.

A study is being made of conditions on the Kongo River between Matadi and Leopoldville for obtaining power to electrify the railway between the two places operated by the Compagnie du Chemin de Fer du Kongo, whose headquarters are at 48 Rue de Namur, Brussels, Belgium. This railway is the connecting link between the Upper and Lower Kongo, and is about 250 miles in length. The river has numerous rapids and falls between the two places, from which it is expected to obtain the necessary power. Freight and passenger rates are at present high, accommodations inadequate, and two days are required to make the trip from Leopoldville to Matadi. A first class electric railway should change these conditions for the better and facilitate the development of the vast territory for which the Kongo River and this railway are the natural outlet.

WATER POWER IN BRITISH COLUMBIA.

Consul Frank C. Denison of Fernie reports that the first plant for the generation of electrical power by water in his district has been successfully inaugurated by the Bull River Electric Power Company at the Bull River Falls, 13 miles due west of Fernie. At this point a fall of 273 feet has been obtained by the construction of a flume 9000 feet long, which takes water from the river above the falls and returns it below. A head of 273 feet with a flow of 462 cubic feet of water per second is available. The flume, constructed of wood and built upon a rock foundation, is 30 feet wide by 7½ feet deep at the intake. The width is reduced to 16 feet within the first thousand feet, this width being kept to the end of the flume. The estimated horsepower that can be utilized is 12,600. The company is now preparing to install the penstock, which is to be of steel, 9 feet in diameter, and will rest upon bedrock the whole length, at an angle of 30 degrees. The foot of the stock will rest upon a natural bedrock, and a T-shaped cross pipe will be placed at the end of the stock in which the wheels will be placed; three wheels of 4200 horsepower each will be utilized as the demand for power develops. The company expects to sell power to the city of Fernie on the east and Cranbrook to the west, and to many of the mining plants within the territory to be reached from its central position. Within a radius of 30 miles there are now in operation steam plants with an aggregate of 23,650 horsepower. Some of this power is used by sawmills, which will continue to employ steam on account of the cheapness of the mill waste used as fuel, but it is expected that many mining and smelting plants within reach of this new plant will discard steam for electrical power. Cranbrook is only 17 miles due west of the plant and Fernie 13 miles east. The company expects to deliver power to the mines at Moyie at a rate that will pay, and as far east as Frank, Alberta. Within this radius there is available undeveloped water power to the extent of 30,000 horsepower, the greatest single power being at Elko, on the Elk River, 20 miles south of Fernie. This estimate does not include the possible power to be developed by damming the different mountain streams in their courses, but is confined to the power available at the various natural falls along the courses of the larger streams. By the expenditure of capital the quantity could be easily doubled.

Examination for Assistant Physicist, Bureau of Standards, is announced by the United States Civil Service Commission on February 8, 1911, to fill vacancies as they may occur in the positions of laboratory assistant (in physics) and assistant physicist in the Bureau of Standards, Department of Commerce and Labor, at salaries varying from $900 to $1200 per annum for laboratory assistant and from $1400 to $1800 per annum for assistant physicist.

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POWER AND GAS

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Changes of advertising copy should reach this office *ten days in advance of date of issue.* New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal," July 1895.
Entry changed to "The Journal of Electricity," September, 1895.
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FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

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We wish you a Happy New Year; may your power factor increase and your load factor never grow less.

Retrospective

Taking stock of the Pacific Coast electrical market for 1910 we find that supply and demand have kept close pace and that both have experienced a healthy increase. Many new electric power plants have been brought into service and many new consumers have been put on the lines. Increased current consumption has induced added purchases of supplies and equipment, so that the dealer and the contractor has been as prosperous as the current seller. Present indications point to even better conditions during the year to come, for electricity is daily becoming more generally used.

More noteworthy than mere increase in consumption is the greater miscellanity of uses to which electric energy is being successfully applied, especially in lessening labor for the Western farmer and miner. By means of electrical irrigation thousands of acres of hitherto arid lands, particularly in the Northwest, have been brought under cultivation and the farmers furnished with cheap power. Electrical mine equipment has reduced the cost of operations so that it is now possible to work ores of lower grade than were formerly profitable; this also with much less danger to life. Electric pumping of oil was first employed in California this year and should greatly augment the present annual production of eighty million barrels. In metallurgical work the Cottrell process for the electrical precipitation of smelter fumes has reanimated the old industry of copper mining, while the electric smelting of iron ore has established a new and needed one. With cheap oil fuel and cheaper as well as better iron, the Pacific Coast bids fair to become a manufacturing center as well as a producer of raw material.

Of the new energy sources, the largest is the 15,000 kilovolt-ampere steam turbo-generator of the City Electric Company of San Francisco. Of the numerous new incorporations, those represented by H. M. Byllesby & Company of Chicago, the Pacific Light and Power Company in the Northwest and the Western States Gas and Electric Company in California, are the largest. Power is now being transmitted at one hundred thousand volts over five Western transmission lines. This year also marked the first Pacific Coast national meeting of the American Institute of Electrical Engineers and the formation of a local branch of the American Society of Mechanical Engineers. The first electric shows to be held in the West were those at San Francisco and Denver. The rapid adoption of the electric vehicle and of the new types of electric lights has been characteristic throughout the coast, though not confined to this section as are most of the big things already mentioned in this brief catalogue of Western achievements.

PERSONALS.

C. L. Cory spent the past week at Los Angeles on engineering business.

W. J. Marland is with the United Light & Power Company as contracting agent.

F. M. Ray, of Foucar, Ray & Simon, Inc., has gone to New York City on business.

J. G. De Remer, assistant general manager of the United Light & Power Company, is at Los Angeles.

H. F. Keyes, manager of the Sacramento Natural Gas Company, was a San Francisco visitor last week.

W. H. P. Hill, manager of the Monterey County Electric Gas & Electric Company was at San Francisco last Monday.

H. F. Jackson, manager of the Sierra & San Francisco Power Company, returned home from a trip to New York last week.

H. E. Merrithew, of the office organization of the Fort Wayne Electric Works, is paying a visit to the firm's San Francisco branch office.

D. C. Henny, construction engineer U. S. reclamation service, has opened an office as consulting hydraulic engineer in the Spaulding building, Portland, Ore.

B. C. Carroll, general agent of the Pacific Telephone & Telegraph Company, returned to his San Francisco office last Tuesday after making a tour of the Pacific Northwest.

E. V. D. Johnson, general manager of the Northern California Power Company, returned to his headquarters at Redding last Tuesday, after spending Christmas at San Francisco.

W. W. Hanscom, consulting electrical engineer, San Francisco, has completed his work on the electrical installation for the Columbia Steel Company and is now working on the equipment of the new Examiner building.

Henry T. Scott, president of the Pacific Telephone & Telegraph Company, returned to San Francisco last week from Washington, D. C., where he spent some time "boosting" for the Panama-Pacific International Exposition of 1915.

L. S. Adams, naval constructor, with the U. S. Navy, passed through San Francisco, en route from the navy yard at Cavite, P. I., to Schenectady, N. Y., where he will inspect work done for the navy by the General Electric Company.

C. E. Groesbeck, second vice-president of H. M. Byllesby & Co., of Chicago, sailed last week for Japan. He will spend several months in foreign travel by way of recreation, after the strain of closing numerous deals for the purchase of electric power plants during the past year.

H. A. Lardner, manager of J. G. White & Co.'s Pacific Coast branch, returned to San Francisco last Thursday after inspecting the Pacific Light & Power Company's new electric power plant at Redondo. The large steam turbines and other apparatus, which have been in successful operation for the past two weeks, were installed by his company.

Paul Shoup, vice-president of the Pacific Electric Railway Company and assistant general manager in charge of electric lines of the Southern Pacific Company, now makes his headquarters at Los Angeles. E. E. Calvin, general manager of the Southern Pacific, spent the past week at Los Angeles advising with Paul Shoup regarding the reorganization of the administrative and office force of the department of electric transportation.

A. C. Sands of Tacoma, Wash., aged 60 years, died in Seattle last week of a nervous breakdown which had extended over a period of two years. He came to Tacoma in 1884 and entered the service of the Sunset Telephone Company as local manager, rising to the position of district manager for Western Washington. He had charge of the construction of the telephone lines of the company in Alaska in 1898. Failing health compelled his retirement last April. He is survived by a widow and two brothers.

TRADE NOTES.

The Standard American Dredging Company of San Francisco has just ordered a 700 h.p. alternating current induction motor from the Westinghouse Electric & Manufacturing Company.

At the San Francisco factory of the Pelton Water Wheel Company, three 4000-h.p., 600-r.p.m., Pelton-Francis turbines which are to be operated under 420 ft. head by the American Smelting & Refining Company are rapidly nearing completion and will be shipped in the near future to Chile. Several of the manufacturing company's staff are now on the ground preparing to install the steel pipe line that is also to be furnished by this company.

On and after January 1st, the sales offices of the Pelton Water Wheel Company of San Francisco, which were formerly in the Monadnock building, will be consolidated with the factory offices at Nineteenth and Harrison streets. The change is made in order to facilitate the turning out of work by preventing the loss of time caused by the separation of the departments. As the drafting rooms, and the accountants' and sales offices are now under one roof, it is expected that business will be carried on more expeditiously throughout.

The Technical Department of the Humboldt Evening School will open for the spring term on Tuesday, January 3, 1911. Classes will continue instruction and be open for new students at that time in architectural and mechanical drawing and the necessary mathematics also in theoretical surveying, mechanics, physics, chemistry and steel square. The work of this school is especially designed for young men engaged in industrial branches of the building and iron trades. A special class in structural engineering has recently been started for architectural and engineering draftsmen and apprentices as well as those engaged in outside steel, wood and concrete construction. Lectures on technical subjects by leading professional men engaged in various specialties will be given during the school year to which the public are invited.

NEW CATALOGUES.

"Heat as the Family Doctor" is the title of an interesting pamphlet from H. W. Johns-Manville Company telling of the curative powers of the J-M Electrotherm.

ERRATA.

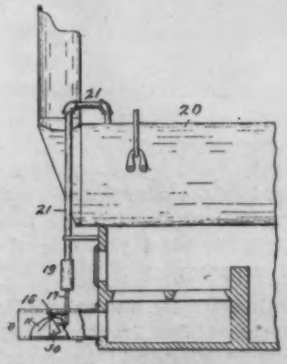
In the article "Starting Induction Motors" in our issue of Dec. 24, 1910, an unfortunate transposition of type obscures the author's meaning in the last column of page 551. Lines 5-19 should be inserted before the last three lines of next to the last paragraph.

JOVIAN DINNER AND REJUVENATION IN CHICAGO.

A Rejuvenation of the Sons of Jove will be held in Chicago on the evening of Friday, January 20, 1911. This rejuvenation will form a part of one of the special days at the Electrical Show, which will be held in Chicago from January 7 to 21. Active committees on membership, dinner and publicity have been organized, and the work is being participated in by the most influential and energetic men of the electrical fraternity of Chicago. It is proposed to initiate a large class of candidates and the beautiful ritual of the Sons of Jove will be carried through in a most impressive manner. Following the initiation there will be a Jovian dinner.

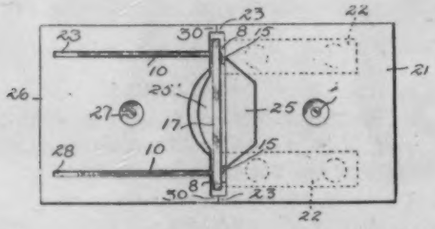
PATENTS

979,069. Draft-Regulator, Frank M. Heath, Portland, Oregon. In a draft regulator, the combination of two dampers co-operating with the same flue or passage, one being movable toward and from the other to vary the size of the draft



passage, automatic heat-operated means for causing movement of one of said dampers to a predetermined position with reference to the flue or passage, and a device actuated by said heat-operated means adapted for controlling the movements of the other damper subsequently.

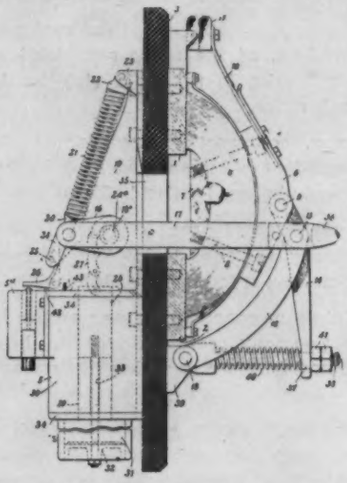
979,050. Electric Switch. John A. Ward, Spokane, Wash. The combination with a base member, of terminal members carried thereon, parallel switch blades pivoted thereon, terminal members spaced from the first named members and adapted to receive said blades therein, an insulating grip bar carried upon the free ends of said switch blades. said bar having a central recessed enlargement adapted for manual engagement to operate the switch, an insulating cover member engaged over said base member and covering said first named terminal members and having parallel narrow slots therein adapted to allow close movement of the switch blades therein, and stopping adjacent said cross bar, a second cover member disposed oppositely of the cross bar, each of said



cover members having extensions meeting at the opposite ends of said cross bar and having opposed finger receiving recesses therein on opposite sides of the cross bar and stopping short of the second named terminal members, said cover members projecting outwardly a spaced distance beyond the outer ends of said second named terminal members, and beyond the central extension of said cross bar to prevent casual engagement and operation of the switch, and to prevent contact of parts of the person with the conducting portions of the switch when closed.

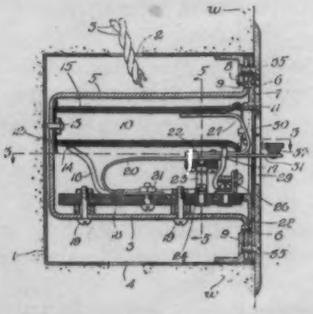
13,184 (re-issue). Meter. Robert Lee Rickman, Vancouver, British Columbia, Canada, assignor of one-half to Samuel Kenrick Champion, Vancouver, British Columbia, Canada. In a meter, in combination, a base, a driven member supported thereby, registering means mounted upon said base, an intermediate mechanism for transmitting motion from said driven member to said registering means, said mechanism comprising a member adapted to be removed and to be replaced by a member of a different size, and means for varying the position of said registering means with respect to said base, whereby to compensate for the difference in diameter of said inserted gear with respect to the replaced gear.

978,882. Circuit-Breaker. Ford W. Harris, Wilkinsburg, Pa., assignor to Westinghouse Electric & Manufacturing Company. A circuit interrupter comprising an insulating slab or plate having an aperture, stationary contact members secured to one surface of the plate at opposite sides of the aperture, movable bridging contact members, operating



means on the opposite side of the plate from the contact members, connecting links extending through the aperture in the plate for establishing an operative connection between the movable contact members and the operating means, and a tension spring for assisting the initial action and for opposing the final action of the operating means in closing the circuit breaker.

978,980. Flush Curling-Iron Heater. James I. Ayer, Cambridge, and Horace B. Gale, Natick, Mass., assignors to Simplex Electric Heating Company. A curling iron heater, comprising a face plate adapted to occupy a position flush with the face of the wall, a wall box inclosing the operative parts of said heater adapted to be set permanently into the wall behind



said face plate, said face plate having an opening for the insertion of a curling iron, a tubular electric heater supported behind said face plate within said wall box for receiving said curling iron, a switch also within said box for controlling the current supply to said heater, and a movable gate behind said face plate for normally closing the opening in the face plate.

INDUSTRIAL

STARTING DEVICE FOR POLYPHASE INDUCTION MOTORS.

The type of motor most widely used for a great variety of industrial purposes, namely, the squirrel-cage type, has one very undesirable feature—it requires a heavy starting current. It is thus essential that the question of the starting device be given careful consideration. Such a device is installed for the purpose of restricting the starting current to such value that it will not cause undue fluctuation of the line voltage, or surging, and also to accelerate the motor evenly from start to full running speed. A simple, efficient, and reliable starting device for alternating-current motors is shown herewith. Fig. 1 and 2 show the general appearance of an Allen-Bradley three-phase compensated starting switch. This starter consists essentially of a three-pole knife switch and an Allen-Bradley compressible resistor connected in shunt across the gap of the switch in each phase, together with suitable mechanism for compressing these resistors and decreasing their resistance.

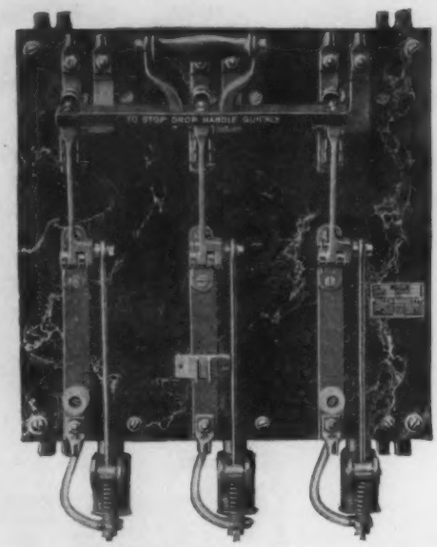


Fig. 1. Front View.

The resistors used in this starter consist of a column of specially prepared graphite discs enclosed in an insulated steel tube, the resistance being varied by varying the compression on the column of discs,, maximum resistance being obtained with minimum pressure and minimum resistance with maximum pressure.

Fig. 1 shows the front view of the motor starter with the lever up or in the running position. The side elevation, Fig. 2, shows the general arrangement of the resistors which are placed at the rear of the slate panel, the perforated metal casing being removed.

The starting operation is as follows: The lever is brought up from the "off" position to a horizontal position, raising the resistor by means of the eccentric and closing the circuit through maximum resistance, which in standard practice with this apparatus allows about 50 per cent of the normal running current to flow. A continued movement of the switch handle compresses the discs, cutting out the resistance gradually until the motor comes up to speed, after which the lever is thrown to the full "on" position, the resistors being short-circuited by the switch blades and clips at a drop in potential of not over 10 per cent of the full voltage. In stopping the motor, the lever is pulled back to the "off" position, as with any other switch, the construction of the mechanism being such that the lever will remain only in the full speed position, or at the "off" position. The circuit being made and broken within the resistance container, the air is excluded and any tendency to arcing reduced to a minimum.

These starters have been subjected to numerous tests, and under the most severe operating conditions have shown exceptional results.

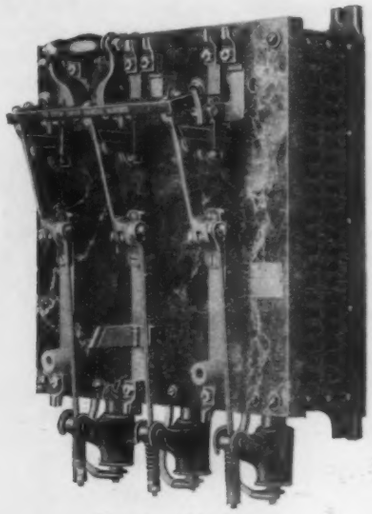


Fig. 2. Side View.

In comparative tests made with a compensated starting switch and auto-starter, operating a 10 h.p., 440-volt, three-phase, squirrel-cage induction motor, the following results were noted: The motor was started under a moderate load of line shafting and with a small blower and pump belted directly to the shafting. With the auto-starter, the motor required about 60 amp. per leg to start, the voltage impressed on the motor terminals being about 200, the line voltage dropping from 410 to 375. With the Allen-Bradley starter the motor was accelerated much more evenly and with less slippage of belts, requiring from 25 amp. to 40 amp. per leg, depending on the time taken in bringing the motor to full speed, 175 volts impressed on the motor terminals, the line voltage dropping from 410 to 395.

The advantages claimed for this form of starting device for induction motors are as follows: Low starting current; elimination of line disturbance; more even and gradual acceleration of motor; light weight; no interruption of the circuit during starting period, and simplicity of construc tion. All parts on the face of the panel are made of copper in accordance with standard switch practice. Extra terminals are provided for starting fuses, these terminals being disconnected in the running position.

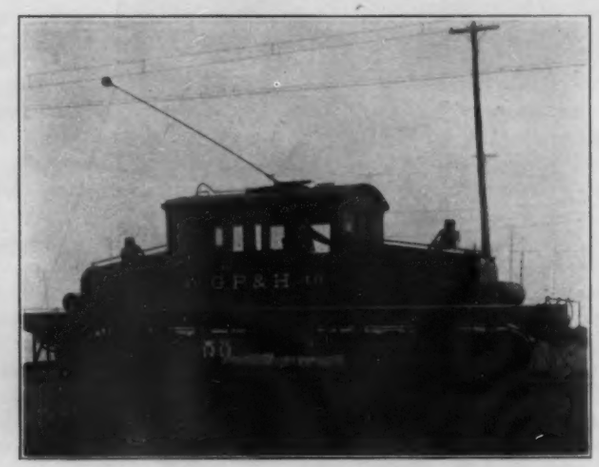
This rheostat is also arranged as a secondary starter for slip-ring type motors. The apparatus is manufactured in sizes ranging from 5 h.p. to 35 h.p., inclusive, by the American Electric Fuse Company, Muskegon, Mich.; San Francisco office, 143 Second street.

F. C. Perkins, formerly manager of the field department of the Reynolds Electric Company, has opened offices in the Bailey building, Seattle, as manager of the Perkins Electric Company, and will buy, sell and exchange electrical machinery.

A NEW FREIGHT LOCOMOTIVE.

The accompanying illustration shows the new electric locomotive recently purchased by the Galt, Preston & Hespeler Street Railway Company, Ltd.., of Ontario, Canada. This company operates some 30 cars on a standard gauge interurban line, 21 miles in length, connecting the above points with the towns of Freeport, Centreville, Berlin and Waterloo. The power station and repair shops are at Preston. The railway traverses a farming country and does a thriving business in both local and through passenger and freight business.

Several years since the G. P. & H. Street Railway Co. purchased from the Westinghouse Electric & Manufacturing Company a quadruple equipment consisting of four No. 93-A direct current motors with a nominal rating of 60 h.p. each at 600 volts, for a locomotive similar to the one shown, but of smaller capacity. Its operation has been eminently satisfactory in every respect and the recent order for a larger



A New Freight Locomotive

locomotive of the same general characteristics argues strongly for the excellence of design and low maintenance charges of this type of slow speed freight locomotive.

Much has been said about the impracticability of electric freight haulage but the steadily increasing sales of slow speed electric locomotives especially designed for freight service and the invariably favorable reports of operation is affirmative evidence of the most forceful nature. There are many interurban electric roads tapping sparsely settled farming districts and outlying towns not favorably located on main steam trunk lines, which could develop a highly profitable express and freight traffic with the aid of a suitable electric locomotive.

The G. P. & H. locomotive shown in the accompanying cut was built by the Baldwin Locomotive Works and the complete electrical equipment furnished by the Westinghouse Electric & Manufacturing Company of Pittsburg, Pa. It is designed for the standard 4 ft. 8½ in. gauge and provided with double swivel trucks. The wheel base is 29 feet and the over-all dimension 36 ft. and it weighs complete, 100,000 pounds. The gear ratio of 16.57 gives a normal speed of 8.25 m.p.h. at which speed a tractive effort of 18,220 pounds is developed. The maximum tractive effort is 25,000 pounds. The locomotive carries a quadruple equipment consisting of four No. 308-B2 interpole, direct-current railway motors having a nominal rating of 100-h.p. each, or a total of 400 h.p. at 600 volts. These motors are fitted with special windings adapting them particularly for slow speed locomotive service. Standard nose suspension is used.

The well known Westinghouse unit switch control was provided, because of its simplicity and uniform positive operation. Two master controllers are supplied, one in each end of the cab. These controllers carry only the small current from a storage battery, for exciting the electro-magnetically actuated needle valve which admits air at 70 lb. pressure to the air cylinders of the unit switch. The action of each switch is therefore positive and independent of fluctuations of the line voltage. It frequently happens on interurban and stub-end lines that the voltage at points far distant from trolley feeders is as low as 200 volts when the motors are in operation. Under such extreme or even less severe conditions solenoid operated contactors, depending upon the line voltage for their contact pressure, are apt to give trouble due to looseness and arcing at the contacts. With air operated switches all such possibilities are eliminated and the greatest reliability under all conditions assured.

APPLICATION OF FAN MOTORS FOR WINTER USE.

It is the popular opinion that the range of usefulness of the electric fan motor is limited to the summer months and that its sole utility lies in its application as a means of reducing the temperature of a room or an office. This is not true, however, and slowly but surely the public is beginning to understand that the usefulness of the fan motor is by no means confined to the hot days of summer, and that paradoxical as it may seem the electric fan blows hot and cold; and incidentally while it is blowing hot it cuts the fuel bill.

Following are a few of the more important applications of the fan motor to winter use:

The efficiency of the hot air heating system may be greatly increased by placing a fan motor in the cold air box to force the air through the registers to all parts of the

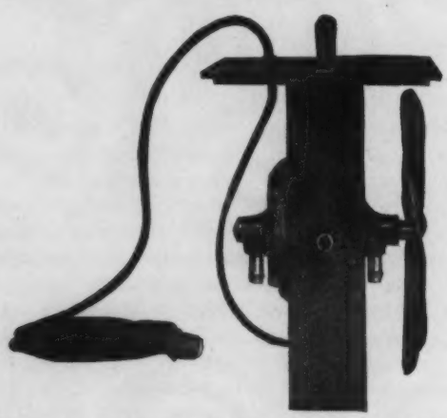


Fig. 1. Exhaust Fan Blower for Furnace.

house. On particularly cold days when the wind is so strong that it forces the air through the furnace into the rooms without having become heated, a fan motor placed in the cold air box, after having closed the slide which permits air to come in from the outside and opening the slide which lets the air in from the cellar, will cause an appreciable rise in the temperature of the room, without making any increase in fuel consumption.

As is very often the case, the house contains a room or rooms which under certain conditions are difficult to heat. This difference can be overcome by placing a fan motor in front of the hot air register or over it in case the register is located in the floor. This plan will prove more efficient if the register and fan motor are covered by a box or hood of some kind which will cause the fan motor to draw air from the pipe only, and not from the room.

In a house heated by hot air or steam, increased radiation of heat and consequently a warmer room may be obtained by placing a fan at the end or back of the radiator.

Another manner in which the fan motor may be used to advantage in winter is to prevent the accumulation of frost

on show windows of stores. The air from the fan motor directed against the glass of the window will keep it practically free from frost. This application of the motor is a

Fig. 2. Exhaust Fan Blower Installed in Furnace.

boon to merchants who have, heretofore, during the cold weather, lost practically all the advantage which their window display accomplishes.

TRAIN DISPATCHING TELEPHONES PROVE THEIR USEFULNESS.

The value of the telephone method of dispatching trains, which has superseded the old familiar telegraph on many of the largest railroads of the country, has been demonstrated by the behavior of this system on the Pere Marquette during recent sleet storms. The telegraph was put out of commission, but the telephone circuit worked continuously and received many words of praise from the railroad people. Telephones and selectors furnished by the Western Electric Company have been placed in service along 136 miles of this road, between Saginaw, Mich., and Toledo, Ohio.

The telephones have been installed at thirty way-stations and four sidings. The service on this division will be watched with interest, as the traffic on the Toledo Division is unusually heavy. Several times in the past the railway has found it necessary to cut the telegraph train wire into two sections in order to handle the traffic, but it is believed that the telephone equipment will enable the work to be handled entirely with one circuit.

The Michigan Central has recently installed train dispatching telephone circuits between Jackson, Michigan and Niles, Ohio, 105 miles, with 34 telephone stations; between Jackson and Bay City, Michigan, 115 miles, with 23 stations, and Jackson and Grand Rapids, Michigan, 94 miles, with 21 stations. Equipment has been ordered for a telephone line between Windsor and St. Thomas, Ontario, Canada, 111 miles, with 20 stations. Plans have been made for the installation of a number of other circuits during the coming year.

WESTINGHOUSE DEVELOPMENTS DURING 1910.

Metallic Flame Arc.

A notable accomplishment in the illumination field was the development of a thoroughly dependable and exceedingly efficient metallic flame arc lamp for operating on multiple circuits. Types have been developed for straight multiple and for multiple-series operation. The negative electrode pencils of metallic oxide are arranged above the positive, metallic buttons, in the Westinghouse lamps. Through this electrode arrangement a maximum amount of light is projected in useful directions.

Wire Type Lamp.

Probably the most notable improvement in electric lighting is the Westinghouse wire type lamp. The wire type lamp was brought to the attention of the public for the first time at the St. Louis convention of the National Electric Light Association; the announcement of the perfection of the methods of manufacturing a single filament lamp created quite a sensation. The wire type lamp rapidly increased in popularity and only six months after its advent it became necessary to increase the manufacturing facilities of the Westinghouse Lamp Company 10,000 lamps per day. The new plant of the Westinghouse Lamp Company is located at 510 to 532 West Twenty-third street, New York City, and is to manufacture exclusively 25, 40 and 60 watt wire type tungsten lamps. The lamp being constructed by an entirely new process it was necessary to develop and manufacture new machinery for the equipment of this plant, which machinery is entirely of American design. The starting of the plant marked the separation of American apparatus from the modified European apparatus, which has heretofore been made to fit American conditions. The factory itself is organized on new lines, which are quite a departure of lamp manufacture in that it is made up of a number of individual factories each independent of the other and all operating in the one plant. The wire type lamp is made with a single filament extending from one leading-in wire to the other with a positive electrical connection between the filament and the leading-in wires. The joint is protected by wrapping the filament around the leading-in wires; this insures flexibility and eliminates points of rigid contact in the lamp. This construction and the improvements in the method of making the filament do away with the fragility that has been present in the ordinary tungsten lamp.

Heating Apparatus.

Westinghouse heating apparatus is being made with only hermetically enclosed resistors. All new devices that were developed in 1910, the resistors are sealed within welded metal jackets and the heaters can readily be removed for cleaning.

Circuit Breakers.

The objection frequently offered to the use of circuit-breakers for motor control has been the lack of any time element in their operation or the fact that they open the circuit instantaneously upon the occurrence of an overload. This fact renders it impossible to set the breaker so that it will protect the motor under operating conditions and at the same time permit the momentary rush of current at starting. A circuit-breaker, therefore, that possesses, in addition to the inherent advantages, a time element similar to that of a fuse without its attendant disadvantages, fills a long felt want in industrial motor applications. Such a device is embodied in the modification of the wall mounting type H oil circuit-breaker originally designed for low-voltage circuits. The inverse time element attachment, which was designed by a well-known engineer, is simple, compact and mounted within the oil tank. It permits the breaker to remain closed during a momentary overload by retarding the movement of the overload trip coil plungers in direct proportion to the extent of the overload. In other words, the time required for the breaker to open varies inversely as the magnitude of the current. This line has been extended to include a switchboard mounting breaker for use on 2500 volt circuits.

Distributing Transformers.

During the year the Westinghouse Electric & Manufacturing Company developed and placed on the market a complete line of distributing transformers for 6600, 11,000 and 16,500 volts. This line, known as the type "SK," parallels the type "S" low-voltage transformers put out by this company in recent years and is meeting with the same success. The new design has taken advantage of the recent developments in silicon steel, improved insulating materials, and other important factors.

Feeder Regulators.

Improvements made in the induction type of feeder regulators by the Westinghouse Electric & Manufacturing Company during the year have resulted in the complete elimination of the chief objection formerly held to regulators of the single-phase type, namely, vibration; the new skeleton frame construction for the stationary element and the use of corrugated sheet iron tanks. All of the accessories for automatic operation have been thoroughly redesigned for long life and minimum attention.

Meters.

In their indicating, recording, portable and watthour meters the Westinghouse Electric & Manufacturing Company have continued the developments pushed forward during past years. Both their alternating current and their direct current watthour meters have been improved with respect to the methods of adjustment and permanence of accuracy. The graphic meters have had improvements in the method of winding the paper feed, and to the already complete line of portable meters has been added a line of millivolt shunts. The switchboard meters have been further standardized and harmonized in appearance and a line of manganin shunts has been added during the year.

Motors.

The developments in motor design during the past twelve months have resulted in the standardization of motors for several important industries. Before a manufacturer can profitably develop a line of motors adapted to the peculiar needs of a given industry there must be sufficient interest in electrical power among the manufacturers in that line to indicate a reasonable demand for the motors when built. Previous to the development of special motors, it is necessary to try standard motors under the conditions to be met and determine wherein they are deficient. The Westinghouse Company has been making very complete investigations in several industries and has developed new types of motors for textile mills, for steel and cement mills, for elevators, for hoists, cranes and railway turntables, and for electrically operated vehicles.

For textile mills a squirrel cage polyphase induction motor must be used and to make possible the thoroughly satisfactory operation of the machines when individually driven standard motors cannot be used. The motors must be absolutely dust-proof because the lint of "fly" in a textile mill will get into the bearings of a standard motor if placed near the floor level and drain out the oil; and in addition the fly will accumulate in the ventilating ducts and finally plug them, acting like a blanket to the motor. Hence, the textile motors have been made without ventilating ducts of any sort and yet are designed to run cool. The bearings have also been made dust-proof and have no openings through which dust or fly can penetrate.

The starting characteristics required particular investigation to secure a motor capable of starting the load, also of operating with high efficiency at its average load. The load conditions of looms, spinning frames, warpers, pickers, dye-house machinery, hydro-extractors, etc., were investigated and each size of motor was specially designed for each class of service.

For steel mills, cement mills and brick yards where the service conditions are most severe a line of squirrel cage polyphase induction motors has been built of more rugged characteristics, both electrical and mechanical, than have characterized any similar motors. Due to the class of labor employed and the necessity of continuity of the work there is little possibility of sparing the machinery from hard knocks. Hence great mechanical strength and extreme simplicity characterize the motors that can satisfactorily meet these conditions; in fact the motors are capable of standing an enormous amount of abuse, and will operate for long periods without attention. The Westinghouse type MS motor is the first squirrel cage induction motor designed especially for mill service.

Because of the difficulties of designing and building a satisfactory alternating current motor for crane service it has been considered necessary in the past to use direct current motors almost exclusively for such service. Considerable expense has sometimes been incurred to install direct current apparatus for the cranes only when all the other machines were driven by alternating current motors.

The new type MW induction motor with wound secondary has just been developed with particularly high torque to fit it for such service. The motor mechanically is similar to the type MS motor with the changes necessary for the phase wound secondary. The electrical characteristics enable the motor to start very heavy loads and lift them at a good speed without taking an excessive current. This permits the small adjustments so necessary in the handling of a crane, without destructive sparking in the control apparatus.

In all induction motors previously built the armatures have been of large diameter and small length as compared with direct current motors of similar capacities, and hence the larger flywheel effects have made the motors less desirable for reversing service. The MW motor armatures are much longer and of smaller diameters, very closely resembling direct curent armatures in their dimensions, and thus the flywheel effects are made so low that these motors are particularly adapted to reversing service.

Owing to the similarity of the services these motors are as well fitted for hoists, elevators, railway turntables and transfer tables, draw bridges and roller lift bridges as for cranes. The simplicity of structure and the absence of complicated wearing parts make these motors peculiarly desirable for severe duty.

For elevator service a modification of the squirrel cage type MS motor has been developed which gives remarkable service. The end rings are designed with special high resistance to give approximately 20 per cent drop in speed from no load to full load, thus not only limiting the starting current, but also increasing the starting torque. This use of the squirrel cage motor materially simplifies the control and provides a motor which is free from any possible wear except in the bearings.

For electric vehicles a line of motors has been developed after a study of the conditions imposed by this service and a careful consideration of each element of the design. These motors are very strong and will successfully withstand the hard usage to which they are subjected. They are very efficient and have a high output per unit of weight. No fuses or other protective devices are required as the motors will take the full current of the battery for which they are designed. There is therefore no danger of opening the circuit in times of emergency. The frames are entirely enclosed and are waterproof. The brushes and commutator are, however, readily accessible for inspection, and any part can be readily removed in case of necessity.

Thus the entire trend of the developments in motors in the past year has been toward the production of new types of motors already built, to suit the requirements of special industries, thus securing greater advantages in the use of electrical power than are possible from general service motors.

NEWS NOTES

INCORPORATIONS.

CORCORAN, CAL.—The Alpaugh Telephone Company has been incorporated by business men of this city with a capital stock of $1500.

SANTA ROSA, CAL.—The Sonoma Valley Water, Light & Heat Company has been incorporated by E. M. and Edna L. Hoen, L. L., L. C. and Mabel Lewis, with a capital stock of $100,000.

LOS ANGELES, CAL.—The Southern Counties Gas Company of California has been incorporated by C. S. Forney, J. H. Badger. R. B. Wheeler, W. A. White and others with a capital stock of $75,000.

SAN FRANCISCO, CAL.—The Union Water Company of California has been incorporated by Alfred D. Plaw, William T. Barnett, E. D. Madison, Platt Kent and V. W. Vincent with a capital stock of $5,000,000.

SAN FRANCISCO, CAL.—The Red Cross Germ Proof Telephone Glass Mouthpiece Company has been incorporated by M. M. Morris, G. W. Merrill, H. H. Davis, G. E. Murphy and Maurice Summerfield, with a capital stock of $500,000.

BOISE, IDAHO.—The Boise Power, Light & Traction Company has been incorporated for $1,000,000 and is making preparations for the construction of a power plant on the Payette River to develop 5000 h.p., and cost $500,000. It is understood that the Telluride Power Company is preparing to spend several million dollars in the completion of its Idaho plans. The main power plant of the company will be constructed at the confluence of the Malad and Snake rivers to furnish 10,000 h.p. to run east and west across South Idaho. The Great Shoshone Falls Light & Power Company, with a plant on the Malad River at Salmon Falls, is arranging to run a line west through southern Idaho to meet competition of the Telluride Company at this place.

SAN FRANCISCO, CAL.—The Poulsen Wireless Company, composed of local capitalists, has filed articles of incorporation in Arizona, with a capital stock of $25,000,000 to exploit in the United States the wireless telegraph and telephone patents of Valdemar Poulsen of Copenhagen. Beach Thompson is president. E. W. Hopkins, George A. Pope. Howard P. Veeder, J. Henry Meyer, S. E. Slade, Charles D. Marx and C. F. Elwell, are among the incorporators. It is stated that the company would not be ready to enter the commercial field for some time. Its work at present, it is said, consisted of a series of experiments and tests. Communication, both by wireless telegraphy and wireless telephone, has been established between San Francisco and Stockton. The local station has been established at the beach.

TRANSMISSION.

PORTLAND, ORE.—The Mt. Hood Railway & Power Company has purchased a site on the East Side fronting on the Willamette river and has let a contract for an auxiliary power plant to Chas. C. Moore & Co., of San Francisco.

GROVELAND, CAL.—The entire holdings of the Tuolumne River Power Company have been sold to a syndicate of capitalists. Lester R. Wiley retains his interest in the new combination and will remain as manager. The new owners will begin development work at once.

NORTH YAKIMA, WASH.—Approximately $2,000,000 will be expended in extensions of lines and services by the Pacific Power & Light Company in the valleys of the Yakima next year. George Arrowsmith, local superintendent, announces the latest improvement planned is the extension of a high tension power wire from the Naches generating plant to the Richland District.

SILVER CITY, N. M.—The Gila River Power Company has been granted rights for the water of the Gila River in Western Grant County. The power company plans to develop 15,000 horsepower.

SPIRIT LAKE, IDAHO.—The Washington Water Power Company has established a camp one mile east of this place and will begin active work on the high tension power lines from Post Falls to Newport.

DIERENGER, WASH.—The Pacific Power Company has awarded a contract to the Allis-Chalmers Company, Milwaukee. Wis., to furnish two 24,000-h.p. high pressure Francis turbines for the power house at Lake Tapps project.

AMERICAN FALLS, IDAHO.—The Idaho Consolidated Power Company will develop 30,000 additional h.p. during the coming year, by building a new power station, which will constitute the main plant of the system, as projected several years ago. Authority for the announcement that the plant will be built the coming year comes from Governor Brady, who controls all the stock of the company.

RENO, NEV.—The Truckee River General Electric Company, of which J. B. Lukes is the local manager, has completed all its surveys and drawings for the building of a new power plant and has let some of the contracts. It will first build a big dam across the Truckee River near the Reno Country Club, as heretofore stated, and at a point a short distance east of Verdi will build a new power-house to generate 3000 h.p. This power will be used for the smelter at Mason City and Waubuska and for the operation of the mines at Yerington.

SAN JACINTO, CAL.—A reservoir site has been purchased by the Ramona Power Company, below Idyllwild. The company has obtained rights for power purposes to practically all the water in the north and south forks of Strawberry Creek, and the waters of these streams will be piped from a point as high up the canyons as possible in order to obtain a maximum drop down to the power-house, to be located in San Jacinto Canyon near the foot of the mountain. After passing through the power-house the waters will be returned to their natural sources, where the water is already owned for irrigation purposes.

TRANSPORTATION.

LONG BEACH, CAL.—The proposed Signal Hill trolley line from Zaferia Junction to the summit of Signal hill, is assured. Money for building the line has been subscribed. The line will cost $100,000.

HAYWARDS, CAL.—The new street railroad franchise from Front street at the depot through C to Watkins and B to the town limits that was applied for by I. B. Parsons, has been read and the clerk has been instructed to advertise for bids.

SAN ANDREAS, CAL.—The Board of Supervisors has received an application from Stanley D. Herbert for a franchise, right, privilege and permission to erect, construct and maintain a broad or narrow gauge track or railway and necessary bridges, in the town of Wallace, County of Calaveras, Cal. Sealed bids will be received for the sale of the franchise up to February 3, 1911.

LOS ANGELES, CAL.—An agreement has been reached between the officials of the Los Angeles Railway Company and leaders of an improvement association who have been making a fight against the erection of car barns on the 13-acre tract south of Agricultural Park. The Railway Company will not build its barns there and will sell its 13 acres to be added to the park. Car barns will be built at the end of the Fifty-fourth street car line.

SAN FRANCISCO, CAL.—The United Railroads have men at work at Market and Sutter streets, engaged in removing part of the rails on the inner tracks and laying a straight rail to replace a part of the switch rail that has heretofore been there. General Superintendent Hibbs explained that the purpose of the work was largely to minimize the heavy noises occasioned by the jar and concussion of the Market-street cars falling upon the much-used rails of the switch connection. He says that it is the same character of work recently put in at the ferry for the same purpose, and will in nowise affect the position of the tracks as they have been. Neither is it the intention to lay a new switch, and the old one will not be taken out.

LOS ANGELES, CAL.—Orders were issued last week by Paul Shoup, vice-president in charge of operations of the Pacific Electric and Los Angeles-Pacific Companies, for the conversion of the Southern Pacific line from Los Angeles to Palms into an electric road. That part of the line between Palms and Santa Monica was converted some time ago. A trolley wire will be strung over the old S. P. tracks from Palms east through Sentous and University to Clement Junction, where the four-track Long Beach line of the Pacific Electric is reached. From there the line will run north to the Arcade station and the Pacific Electric's station at Sixth and Main streets. Over this line all freight for the Santa Monica bay district, whether it comes by land or water, will be transported.

SACRAMENTO, CAL.—That a branch line will be constructed by the Northern Electric, crossing the Haggin Grant tract from the main line eastward, skirting the south end of the proposed City Park crossing into Carmichael Colony, touching the Country Club tract and proceeding on to Fair Oaks and Orangeville, was decided last week at a conference between Northern Electric officials and persons interested in the great agricultural district. The branch will be built during the coming year, according to D. W. Carmichael. The branch will deflect from the main line at Del Paso Station on the Haggin Grant and run a little north of east toward the proposed City Park. Skirting the south point of the park site the road will turn due east across the grant. The survey for this branch has been completed, as has that for the line into Fair Oaks and Orangevale.

ILLUMINATION.

ELSINORE, CAL.—Mrs. M. A. Gardner and M. L. Camburn made application for a 50-year gas franchise.

CAMAS, WASH.—E. E. Goff of Portland has applied to the City Council for an electric light franchise and has secured a power site on the Washougal River, where he proposes to establish a 500 h.p. plant if the franchise is granted.

LA GRANDE, ORE.—James Lambirth, representing a company who proposes to put in a gas plant for La Grande, is here and has submitted a proposal for a franchise to lay mains through the streets and alleys. The plant and equipment and pipe connections will cost about $150,000.

LOS ANGELES, CAL.—The Los Angeles Gas & Electric Company will erect a two-story and basement re-inforced concrete office building at Aliso and Center streets and an office building for the electrical department. The company is having plans made for a steel gas holder to contain 6,000,000 cu. ft. of gas.

LOS ANGELES, CAL.—One of the largest mortgage issues ever made in Los Angeles was given yesterday when the Southern California Gas Company issued $10,000,000 in first mortgage 40-year gold bonds. The Trust Company of America is named as trustee. Some of the money will be used to extend gas mains to San Bernardino and to complete the Redondo plant.

LONG BEACH, CAL.—The formal issuance of $400,000 worth of bonds recently authorized for the building of the Consolidated gas plant in Long Beach, was made at the meeting of the directors last week. The directors authorized the expenditure of $132,000 immediately. The remainder of the amount will be used in liquidating certain indebtedness and future use in the building of the plant.

BAKERSFIELD, CAL.—The California Natural Gas Company has purchased four acres at Palm and Oak streets in the Ellery Green tract at the southwestern limits of the city, and will there establish its buildings in connection with the delivery of natural gas into the distributing system of the local gas company. What the company will need of so much land is not known, as a reducing valve and a meter are about all the equipment it is likely to need at this point, so far as is known to the general equipment. The work of laying the pipe to bring the two systems to the connecting point is progressing well on both sides of the line, but the local company is expected to finish first. The holders at that point will be used to keep a stock of gas on hand against any emergency.

PORTLAND, ORE.—Expenditures aggregating $2,250,000 will be made by this company and the Pacific Power & Light Company during the coming year, according to announcement made by Guy W. Talbot, president of both concerns. Of this sum $750,000 will be spent in extending the mains and improving the plant of the Portland Gas & Coke Company. The remaining $1,500,000 will be used in the further development of the light and power company's service along the Columbia and Yakima rivers in Eastern Washington, making possible the irrigation of a large area. Work on the local improvements will be started early in 1911. About 200 miles of gas mains will be laid. Additions will be made to the local generating plant to accommodate the increased service. The new mains so far as possible, will cover those districts in which the city is planning hard-surface improvements but many of the suburban streets will also be served.

TELEPHONE AND TELEGRAPH.

RED BLUFF, CAL.—Word has been received here that the wireless telegraph station of the Northern California Power Company at Volta, near Manton on the Shasta and Tehama county line, was destroyed last week by a thunderbolt during a heavy storm. This is the first instance known here where a wireless telegraph plant has been struck by lightning. The Northern California Power Company maintains wireless plants at each of its hydroelectric power plants for the purpose of communicating with one another and with the home office in Redding in case the telephone lines are down or when storms make them dangerous.

FRESNO, CAL.—It is announced that extensive additions are planned for the local telephone system. The changes are to come soon after the first of the year and are to include an extension of the local system to the northwest of the city. It is stated that there is a possibility of extending the telephone lines to the Kearney Boulevard tract, now on sale. One of the main improvements contemplated is the laying of more underground cables in the downtown district. These will not displace the present overhead wires but it is not desired to string more wires above ground than necessary, and telephone officials hope that additional lines may be placed in conduits below street level.

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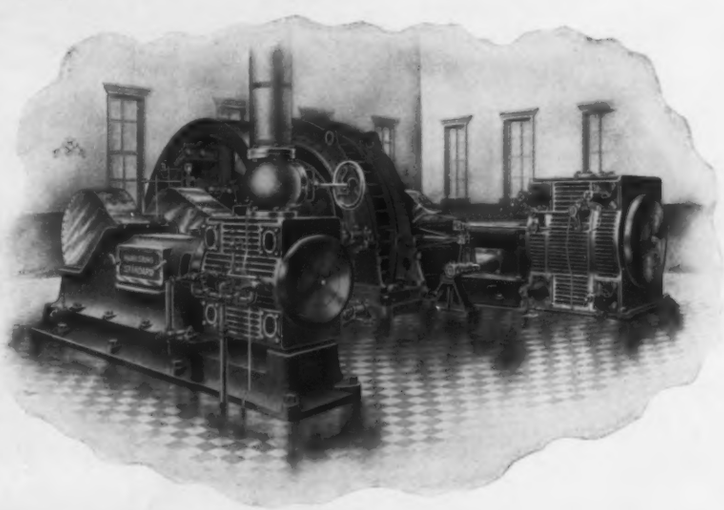

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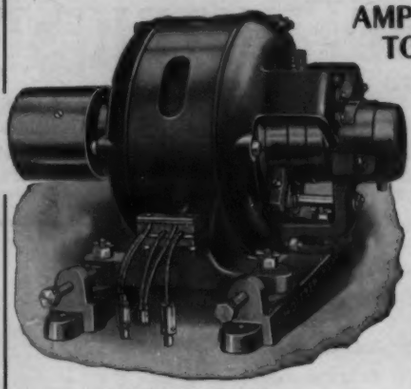

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These boxes are substantially built of iron and can be secured to cross arms by means of four wood-head screws through outside feet.

The cover is securely closed by two pivot studs with wing nuts and may be sealed, rendering it fool-proof.

The cut-out is amply protected by the iron box and has a base of ash impregnated by the vacuum process with linseed oil, making it far superior to porcelain, fibre or slate, from both a mechanical and di-electric standpoint. This oil makes the base absolutely weatherproof.

The base is mounted on two bosses (just off center) which gives the greatest possible leakage surface by surrounding it with air.

All contacts are of the well-known "Noark" thimble lug type, making perfect contact.

A wooden fuse carrier handle is provided and has brass-plated steel clips with snap latches which lock under fuse blade and cannot be opened by accident. In inserting a fuse, it is first locked in carrier and thus placed in contact clips. The operator is protected from contact with live metal parts by this means.

Each box is figured with a very high factor of safety for both spacing and leakage, thus guarding against break-downs from surges on the line.

The fuses are designed to open a short circuit at 5000 volts but are rated and intended for use on 2500-volt circuits.

Every box is tested at 400% overload or at a potential of 10,000 volts before shipment.

Write nearest branch for full particulars.

H. W. JOHNS-MANVILLE CO.

ASBESTOS

Manufacturers of Asbestos and Magnesia Products, Asbestos Roofings, Packings, Electrical Supplies, Etc.

Baltimore	Cleveland	London	NewOrleans	SanFrancisco
Boston	Dallas	Los Angeles	NewYork	Seattle
Buffalo	Detroit	Milwaukee	Philadelphia	St. Louis
Chicago	Kansas City	Minneapolis	Pittsburg	

For Canada:—CANADIAN H. W. JOHNS-MANVILLE CO., Limited
Toronto, Ont. Montreal, Que., Winnipeg, Man., Vancouver, B. C.

For Great Britain and Continent of Europe:
TURNERS & MANVILLE, LTD., Hopetoun House, 5 Lloyds Ave., London, E. C.

1217

The Schaw-Batcher Co. Pipe Works

(INCORPORATED)

Manufacturers of **RIVETED IRON AND STEEL PIPE**

Tanks of all descriptions for Water, Oil and Gas. Single and Double Well Casing

OUR SPECIALTY: Riveted Pipe for High Pressure

Engineers and Contractors for the complete installation of Pipe Lines used in the operation of Hydraulic Mines, Power Plants, Water Works, Irrigation, Reclamation, etc. We have special facilities for supplying general supplies for Mills, Mines, etc.

Office, 211 to 219 J Street **Works, 15th and B Streets**

SACRAMENTO, CAL.

San Francisco Office, 356 Market St. **New York Office, 65 Reade St.**

E. C. HUGHES, PRESIDENT ADOLPH MEESE, SECRETARY

E. C. HUGHES CO.

PRINTERS — ENGRAVERS — BOOKBINDERS

LET US FIGURE ON YOUR CATALOGUE AND OTHER PRINTED MATTER

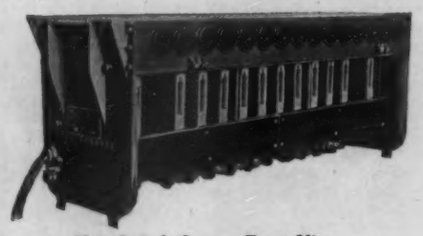
Printers and Binders of the Journal of Electricity and other Publications

147 to 151 Minna Street, San Francisco. Phone Kearny 806

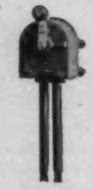
Westinghouse

Unit Switch Control Systems

for every class of electric traction service



Unit Switch Group—Front View
Lower Cover Removed



Master Controller

Circular No. 1091 illustrates and describes the "Automatic" Unit Switch Control System. Ask nearest office for a copy.

The Automatic Type

Absolutely reliable operation independent of fluctuations in trolley voltage.

Automatic uniform acceleration with correspondingly low power consumption.

Low maintenance costs results from:

1.—High pressure between contacts and effective magnetic blow-out, which insure long life of unit switches.

2.—Low voltage interlocks, which prevent burning of fingers, with the consequent failures and renewals.

3.—Light weight of parts.

Westinghouse Electric & Mfg. Co.

PITTSBURGH, PA.

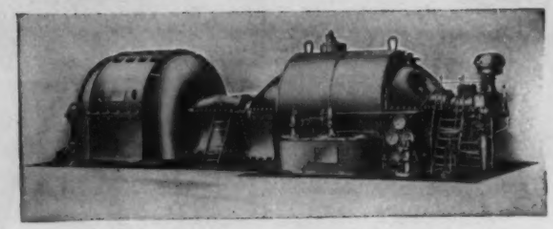
Los Angeles, 527 South Main St.
Denver, 429 Seventeenth St.
Seattle, Central Bldg.
Salt Lake City, 212-214 South West Temple St.

Westinghouse Electric & Mfg. Co. of Texas, Dallas and El Paso, Texas
Canada, Canadian-Westinghouse Co., Ltd., Hamilton, Ontario
Mexico, G. & O. Braniff & Co., City of Mexico

San Francisco, 165 Second St.
Spokane, Columbia Bldg.
Portland, Couch Bldg.
Butte, Mont., Lewisohn Bldg.

Westinghouse Steam Turbines

Two elementary parts, the spindle and the cylinder



Westinghouse Double-Flow Steam Turbine.

are most prominent in Westinghouse Turbine construction.—Packing, the source of so much trouble and expense in reciprocating steam engine construction, is not used at all. There are no leaky pistons to be made tight, nor reciprocating parts to be keyed up. The condenser water, being free from oil, can be returned direct to the boilers. **See Circular No. 502**

The Westinghouse Machine Co.

PITTSBURG, PA.

Steam Turbines, Steam Engines, Gas Engines, Gas Producers, Condensers and Mechanical Stokers

Pacific Coast Representatives HUNT, MIRK & CO., Inc. 141 Second St., San Francisco

Engineers for Complete Power Plant Installations

Greenfield Flexible Steel Armored Conductors

THE HARMONY CLUB, NEW ORLEANS, LA.
Wired with Greenfield BX Conductors

(THE ONLY TRADE BX MARK CABLE)

When you can procure the best conductors within the limits of the most conservative expenditure, do not consider substitutes. For wiring existing buildings, these flexible conductors are absolutely the best obtainable. They can be drawn or fished through without damage to walls or floors, and save time and expense. It will pay you to look into this.

Write for a copy of pamphlet No. 42954.

SPRAGUE ELECTRIC COMPANY

General Offices: 527-531 West 34th Street, New York City

SAN FRANCISCO, Atlas Building
SEATTLE, - Colman Building

The Pacific Gas and Electric Company

Supplies Light, Heat, and Power

TO

Place.	Population.
Agua Caliente	50
*Alameda	27,000
**Albany	800
‡‡Alta	200
Alvarado	200
Amador	200
Antioch	3,000
‡‡Auburn	2,050
Barber	200
**Belmont	600
Belvedere	350
Benicia	2,500
**Berkeley	42,000
Big Oak Flat	150
Biggs	750
Black Diamond	500
Brentwood	200
Brighton	100
Broderick	500
‡Brown's Valley	50
**Burlingame	5,000
Byron	200
Campbell	1,000
Cement	1,500
‡Centerville	20
Centerville	500
**Chico	13,000
**Colusa	2,700
‡Colfax	400
Colma	500
Concord	1,500
Cordelia	150
Corte Madera	350
Crockett	2,500
Crow's Landing	370
Davenport	1,000
Davis	750
Decoto	350
Dixon	1,000
Dobbins	50
Drytown	100
Durham	500
‡Dutch Flat	400
**Easton	500
**East San Jose	1,500
Eckley	20
Emerald	50
Elmhurst	2,500
Elmira	150
El Verano	100
**Emeryville	2,000
Encinal	20
Fairfield	800
** Fair Oaks	250
Fitchburg	250
Folsom	1,500
*Fresno	35,000
Glenn Ellen	500
Gold Run	100
Grafton	350
†Grass Valley	7,000
Gridley	1,800
Groveland	50
Hammonton	500
Hayward	4,000
Hollister	3,000
Ione	900
Irvington	1,000
Jackson	3,000
Jackson Gate	50
Larkspur	950
Lawrence	100
Kennedy Flat	50
Kentfield	200
‡Lincoln	1,500
‡Live Oak	200
Livermore	2,250
‡Loomis	150
Los Altos	200
Los Gatos	3,000
Mare Island	500
Martell	25
Martinez	5,000
**Marysville	6,250
Mayfield	1,500
**Menlo Park	1,500
Meridian	300
**Milbrae	300
Mill Valley	4,500
Mission San Jose	500
Mokelumne Hill	150
Mountain View	2,500
**Napa	6,000
†Nevada City	4,000
Newark	700
‡Newcastle	600
New Chicago	25
Newman	1,000
Niles	800
**Oakland	230,000
Oroville	2,500
Orwood	50
Pacheco	200
**Palo Alto	6,000
‡Penryn	250
Perkins	200
**Petaluma	6,000
Peyton	250
**Piedmont	2,000
Pinole	1,500
Pleasanton	2,000
Port Costa	600
**Redwood City	3,500
Richmond	10,000
Rio Vista	200
‡Rocklin	1,050
Rodeo	100
‡Roseville	245
Ross	900
***Sacramento	52,000
San Andreas	200
San Anselmo	2,500
San Bruno	1,500
San Carlos	100
**San Francisco	450,000
**San Jose	40,000
San Leandro	4,000
San Lorenzo	100
**San Mateo	7,000
San Pablo	1,000
**San Quentin Prison	1,600
**San Rafael	6,000
Santa Clara	8,000
Santa Cruz	10,000
**Santa Rosa	8,000
Saratoga	200
Sausalito	3,000
Sebastopol	2,000
Selby	100
Sonoma	1,200
South San Fran	2,500
Stanford Univ	2,000
Stege	100
‡Stockton	25,000
Suisun	1,200
Sunnyvale	2,000
Sutter Creek	2,000
Tiburon	100
Tormey	150
‡Towle	200
Tracy	1,200
Vacaville	2,500
**Vallejo	12,000
Vallejo Junction	10
Walnut Creek	350
Wheatland	1,400
Winters	1,200
**Woodland	3,500
Yolo	350
**Yuba City	1,900

*Gas only; **gas and electricity; †electricity, gas, and water; ‡electricity and water; ***gas, electricity, and street car service; all others, electricity only.

Service Furnished	Number of Towns	Total Population
Electricity	158	1,089,790
Gas	33	988,900
Water	17	43,415
Street Car	1	52,000

EMPLOYS 3,500 people

OPERATES 11 hydro-electric plants in the mountains
3 steam-driven electric plants in big cities.
18 gas works

SERVES ⅔ of California's population
26 of California's 56 counties
An area of 32,431 square miles
3/5 the size of New York state
½ the size of all the New England states combined

18 Million Readers

have learned the advantages of Electric Lighting

EVERY month since last September millions of readers of the most widely read magazines have learned that electric lighting with its many advantages, is now well within the means of all who live within the borders of a lighting circuit.

Thousands of these readers have written for further information, proving that a widespread interest has been created. Many of these inquirers stated that they were using other methods of lighting; the arguments were reaching not only the non-user of electric service, but also those who feel the need of more light.

From coast to coast lighting companies have written favorably of this campaign because they have found it helpful in extending the use of electric lighting on their circuits.

This extensive advertising in the popular magazines is but one part of the widespread campaign to popularize electric lighting with MAZDA Lamps.

General Electric Company

Main Lamp Sales Office: HARRISON, N. J.
Principal Office: SCHENECTADY, N. Y.

2523A

These Trade Papers Help You to Sell More Current

IN addition to the widespread advertising in the popular magazines, the campaign for more ELECTRIC light is also carried on through the columns of a long list of representative trade papers.

Bankers, building managers, hotel owners, manufacturers, shoe dealers, hatters, haberdashers, clothiers, furnishers, dry goods men, furniture dealers, house furnishers, jewelers, druggists, hardware dealers and others have learned that an electrically lighted store is a business asset—that brilliancy brings business.

One of the quickest and best ways to reach the influential members of a particular trade is through the columns of the journal published in the interests of that trade. These trade papers contain information vital to the trade and are read with keen interest.

In these papers the same arguments are used that you would use to induce business men to use your service.

This broad campaign makes it easy for you to extend the use of electric lighting on all parts of your circuit.

SALES OFFICES IN THE FOLLOWING CITIES:

Atlanta, Ga.
Baltimore, Md.
Boston, Mass.
Buffalo, N. Y.
Butte, Mont.
Charleston, W. Va.
Charlotte, N. C.
Chicago, Ill.
Cincinnatti, O.
Cleveland, O.
Columbus, O.
Denver, Colo.
Detroit, Mich.
(Office of Sol'g Agt.)
Indianapolis, Ind.
Kansas City, Mo.
Los Angeles, Cal.
Minneapolis, Minn.
Nashville, Tenn.
New Haven, Conn.
New Orleans, La.
New York, N. Y.
Philadelphia, Pa.
Pittsburg, Pa.
Portland, Ore.
Richmond, Va.
Salt Lake City, Utah
San Francisco, Cal.
St. Louis, Mo.
Seattle, Wash.
Spokane, Wash.
Syracuse, N. Y.

2523B

Take Advantage of this Newly Aroused Interest in Electric Lighting

To reap the full benefit of the universal interest in electric lighting created by our general advertising, start a local campaign of your own. You can crystallize general interest into a particular local interest — the inevitable result of which will be the sale of more current to more customers.

A series of out-of-the-ordinary street car cards and newspaper advertisements, brimful of result-getting arguments, brings the kind of results that keep a new business department hustling from daylight to dark.

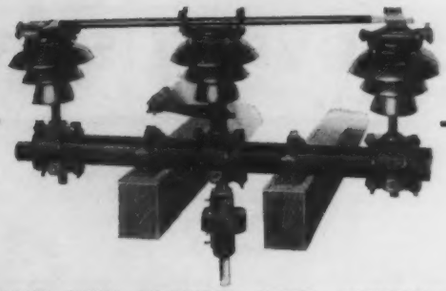
You can do that kind of advertising without having to employ a staff of artists and advertising experts because the entire advertising department of the General Electric Company is at your service. Advertising experts have prepared a series of car cards and newspaper advertisements that will build up the volume of your business by adding to your customers' list the present non-user of your service and by increasing the amount of current used by present customers.

These newspaper advertisements, electrotyped and all ready for your local printer, will be furnished free of charge to progressive lighting companies, together with a full series of street car cards, imprinted with your firm name.

It is decidedly to your advantage to write at once for complete particulars. Address 2625c

General Electric Company

Advertising Dept. Schenectady, N. Y.

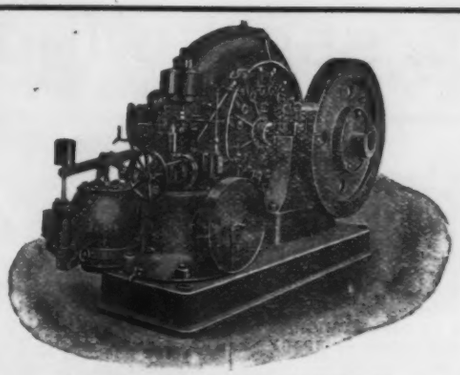


WE HAVE NOW ADOPTED STEEL CONSTRUCTION
For our well-known Poletop Switches
SEND FOR BULLETIN "J"
PACIFIC ELECTRIC & MANUFACTURING CO.
80 Tehama Street, San Francisco

Chicago Insulated Wire & Mfg. Co.
Chicago. Factory: Sycamore, Ill.
DOUBLE AND TRIPLE BRAID
Weatherproof Wires
THE BEST ON TEST
Our Double Cotton Covered Magnet Wire
Cannot be Excelled.
Complete Stock in Los Angeles
B. F. KIERULFF, Jr. & CO., Agents
120 So. Los Angeles Street, Los Angeles

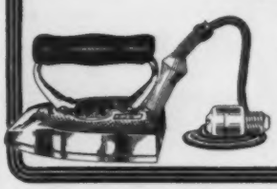
Do away with the old method of "leading in"
It's slow and unworkmanlike. Electricians are gradually waking up to the fact that there is a better way. The majority of them now use
Star Screw Anchors
for attaching switches, bells, push buttons, etc. 25,000 telephone companies use them.
Write for catalogue 73 and samples, free upon request
Star Expansion Bolt Co.
Catalogue Department 73 147 Cedar St., New York

Western Wireless Equipment Co.
Complete Commercial Wireless Sets Installed
SPECIAL EQUIPMENTS FURNISHED FOR
Hotels, Vessels, Private Yachts, Power Boats, Etc.
Pacific Coast Representatives of
Wireless Specialty Apparatus Co., N. Y.
Sole Owners and Manufacturers of Silicon, Perikon and Pyron Detectors
The Celebrated I-P-76 Selective Long Distance Receiving Set and Pickard Adjustable Head Telephones
San Francisco Office, Grant Building, 7th and Market Streets



PELTON-FRANCIS TURBINE AND GOVERNOR
Francis Turbine Water Wheels
of any capacity contracted for and installed
Write for Catalog and List of Operating Plants
THE PELTON WATER WHEEL CO.
1011 MONADNOCK BLDG., SAN FRANCISCO, CAL.
84 WEST ST., NEW YORK CITY

"AMERICAN" ELECTRIC IRONS
give the user perfect satisfaction on the ironing board. They are built with fifteen years experience behind them.
They are the irons for you to sell.
We also make every other practical electric heating device, such as toaster, disc heaters, water heaters, air heaters, etc.
Send for catalog.



American Electrical Heater Co.
DETROIT. U. S. A.
Oldest and largest exclusive makers in the world.

POLES CEDAR, Round and Sawn
Sawn Redwood Poles, Fir and Cedar Piling,
TIES -- RAILROAD TIMBERS
R. B. SWAYNE 813 Postal Telegraph Building
San Francisco. Yard at Oakland

Thé Tracy Engineering Co.
EDGE MOOR WATER TUBE BOILERS
NORDBERG CORLISS ENGINES AND COMPRESSORS
Sheldon Bldg., San Francisco -- Central Bldg., Los Angeles

Foster's Electrical Pocket Book
For quick and easy reference this book is a marvel. Not only is the index so complete as to enable you to find any data desired at once, but it is provided with a PATENT THUMB INDEX TAB separating each division of the book, making reference practically instantaneous. Mailed $5.00
TECHNICAL BOOK SHOP, 604 Mission St., San Francisco

CLASSIFIED INDEX TO ADVERTISERS

MATERIAL THEY ARE PREPARED TO FURNISH

Adapters, Lamp
Benjamin Electric Mfg. Co.
General Electric Company

Alarms, Burglar
Electric Goods Mfg. Co.
Partrick, Carter & Wilkins Co.
Western Electric Company

Alarms, Fire
Partrick, Carter & Wilkins Co.
Western Electric Company

Alarms, Water
Patrick, Carter & Wilkins Co.

Anchors, Guy
Johns-Manville Co., H. W.
Kieruliff, B. F. Jr. & Co., Inc.

Anchors, Screw
Star Expansion Bolt Co.

Annunciators
Electric Goods Mfg. Company
Partrick, Carter & Wilkins Co.
Telephone & Elec. Equip Co.

Arms, Cross
Kieruliff, B. F. Jr. & Co., Inc.
Western Electric Company

Arms, Mast
Fort Wayne Electric Works
Kieruliff, B. F. Jr. & Co., Inc.
Western Electric Company

Arms, Desk Phone
Kieruliff, B. F. Jr. & Co., Inc.
Western Electric Company

Asbestos
Johns-Manville Co., H. W.

Asbestos, Wood
Johns-Manville Co., H. W.

Batteries, Dry
Electric Goods Mfg. Company
Johns-Manville Co., H. W.
Kieruliff, B. F. Jr. & Co., Inc.
Western Electric Company

Batteries, Medical
Partrick, Carter & Wilkins Co.

Batteries, Wet
Electric Goods Mfg. Company
Partrick, Carter & Wilkins Co.
Western Electric Company

Batteries, Storage
Electric Storage Battery Co.
Westinghouse Machine Co.

Bells, Electric
Electric Goods Mfg. Company
Partrick, Carter & Wilkins Co.
Western Electric Company

Bells, Magneto
Electric Goods Mfg. Company
Kieruliff, B. F. Jr. & Co., Inc.
Kellogg Swbd. & Supply Co.
Western Electric Company

Boilers
Moore & Co., Chas. C.
Tracy Engineering Company

Boxes, Wall
Benjamin Electric Mfg. Co.
General Electric Company
Sprague Electric Company
Telephone & Elec Equip. Co.

Brackets, Iron Pole
Kieruliff, B. F. Jr. & Co., Inc.
Pierson, Roeding & Co.

Burners, Gas Lighting
Electric Goods Mfg. Company
Western Electric Company

Cables, Submarine and Lead-Covered
General Electric Company
Habirshaw Wire Company
Kieruliff, B. F. Jr. & Co., Inc.
Okonite Company, The
Standard Und. Cable Co.
Simplex Electrical Company
Western Electric Company

Cables, Telephone
Kellogg Swbd. & Supply Co.

Carbons, Arc Light
Chas. L. Kiewert Co.
Reisinger, Hugo

Car Skids
Kieruliff, B. F. Jr. & Co., Inc.

Circuit Breakers
Fort Wayne Electric Works
General Electric Company
Kieruliff, B. F. Jr. & Co., Inc.
Pacific Elec. & Mfg. Co.
Westinghouse E. & M. Co.
Western Electric Company

Clamps, Ground
General Electric Company
Thomas & Sons Co., R.

Cleats, Fibre
Blake Signal & Mfg. Co.

Cleats, Porcelain
General Electric Company
Western Electric Company

Clusters, Fixture
Benjamin Electric Mfg. Co.
General Electric Company

Coils, Armature
D. & W. Fuse Company
General Electric Company
Westinghouse E. & M. Co.
Western Electric Company

Coils, Induction
Electric Goods Mfg. Company
Kellogg Swbd. & Supply Co.
Partrick, Carter & Wilkins Co.
Western Electric Company

Coils, Spark
Electric Goods Mfg. Company
Western Electric Company

Compounds, Boiler
Dearborn Drug & Chem. Wks.
Johns-Manville Co., H. W.

Conduit, Flexible
American Circular Loom Co.
Sprague Electric Company
Telephone & Elec. Equip. Co.

Conduit, Rigid
American Circular Loom Co.
Kieruliff, B. F. Jr. & Co., Inc.
Sprague Electric Company
Telephone & Elec. Equip. Co.

Conduit, Underground
Johns-Manville Co., H. W.
Pierson, Roeding & Co.
Western Electric Company

Connectors, Cable
Kieruliff, B. F. Jr. & Co., Inc.

Cord, Flexible Bell
General Electric Company
Kieruliff, B. F. Jr. & Co., Inc.
Pierson, Roeding & Co.
Simplex Electrical Company
Western Electric Company

Cord, Lamp
General Electric Company
Okonite Company, The
Pierson, Roeding & Co.
Simplex Electrical Company
Sprague Electric Company
Standard Und. Cable Co.
Western Electric Company

Cord, Telephone
Kellogg Swbd. & Supply Co.
Kieruliff, B. F. Jr. & Co., Inc.
Pierson, Roeding & Co.
Simplex Electrical Company
Western Electric Company

Braces, Cross-Arm
General Electric Company
Kieruliff, B. F. Jr. & Co., Inc.
Westinghouse E. & M. Co.

Cut-Outs, Arc
Fort Wayne Electric Works

Cut-Outs, Incandescent
D & W. Fuse Company
General Electric Company
Westinghouse E. & M. Co.

Cut-Outs, Transformer
D. & W. Fuse Company
General Electric Company
Westinghouse E. & M. Co.

Dynamos, A. C.
Eng. & Maintenance Co.
Fort Wayne Electric Works
General Electric Company
Westinghouse E. & M. Co.
Western Electric Company

Dynamos, D. C.
Eng. & Maintenance Co.
Fort Wayne Electric Works
General Electric Company
Sprague Electric Company
Westinghouse E. & M. Co.
Western Electric Company

Dynamometers
Sprague Electric Company

Hoists, Electric
Sprague Electric Company

Novelties, Electric
American Elec. Heater Co.

Engines, Gas and Gasoline
Moore & Co., Chas. C.
Henshaw-Bulkley & Co.
Hunt, Mirk & Co.
Kieruliff, B. F. Jr. & Co., Inc.
Tracy Engineering Company
Westinghouse Machine Co.

Engines, Marine
Westinghouse Machine Co.

Engines, Steam
Moore & Co., Chas. C.
Hunt, Mirk & Co.
Tracy Engineering Co., The
Westinghouse Machine Co.

Fans, A. C. Portable
Fort Wayne Electric Works
General Electric Company
Johns-Manville Co., H. W.
Westinghouse E. & M. Co.
Western Electric Company

Fans, D. C. Portable
Fort Wayne Electric Works
General Electric Company
Johns-Manville Co., H. W.
Sprague Electric Company
Westinghouse E. & M. Co.
Western Electric Company

Fans, A. C. Ceiling
Westinghouse E. & M. Co.

Fans, D. C. Ceiling
General Electric Company
Sprague Electric Company
Western Electric Company
Westinghouse E. & M. Co.

Fans, Exhaust
General Electric Company
Western Electric Company
Westinghouse E. & M. Co.

Fixtures, Ceiling, Bracket, Etc.
Benjamin Electric Mfg. Co.

Fixtures, Marine
Benjamin Electric Mfg. Co.

Fixtures, Show Case
Benjamin Electric Mfg. Co.
Johns-Manville Co., H. W.

Fuse Boxes
D. & W. Fuse Company
Johns-Manville Co., H. W.
Westinghouse E. & M. Co.

Fuse, Enclosed, and Fittings
D. & W. Fuse Company
General Electric Company
Johns-Manville Company.
Western Electric Company
Westinghouse E. & M. Co.

Fuse Wire and Links
General Electric Company
Pierson, Roeding & Co.

Fuses, Miscellaneous
General Electric Company
Westinghouse E. & M. Co.

Fuses, Telephone
D. & W. Fuse Company
Kieruliff, B. F. Jr. & Co., Inc.
Western Electric Company

Gongs, Electro-Mechanical
Electric Goods Mfg. Company
Partrick, Carter & Wilkins Co.

Governors, Water-Wheel
Pierson, Roeding & Co.

Guards, Wire Lamp
Benjamin Electric Mfg. Co.

Hangers, Cable
Kieruliff, B. F. Jr. & Co., Inc.
Standard Und. Cable Co.

Heating Material, Including Soldering Irons, Sad Irons, Etc.
American Elec. Heater Co.
General Electric Company
Johns-Manville Co., H. W.
Pacific Electric Heating Co.
Simplex Elec. Heating Co.
Westinghouse E. & M. Co.

Hose, Armored
Sprague Electric Company

Hoods, Street
Fort Wayne Electric Works
General Electric Company
Kieruliff, B. F. Jr. & Co., Inc.
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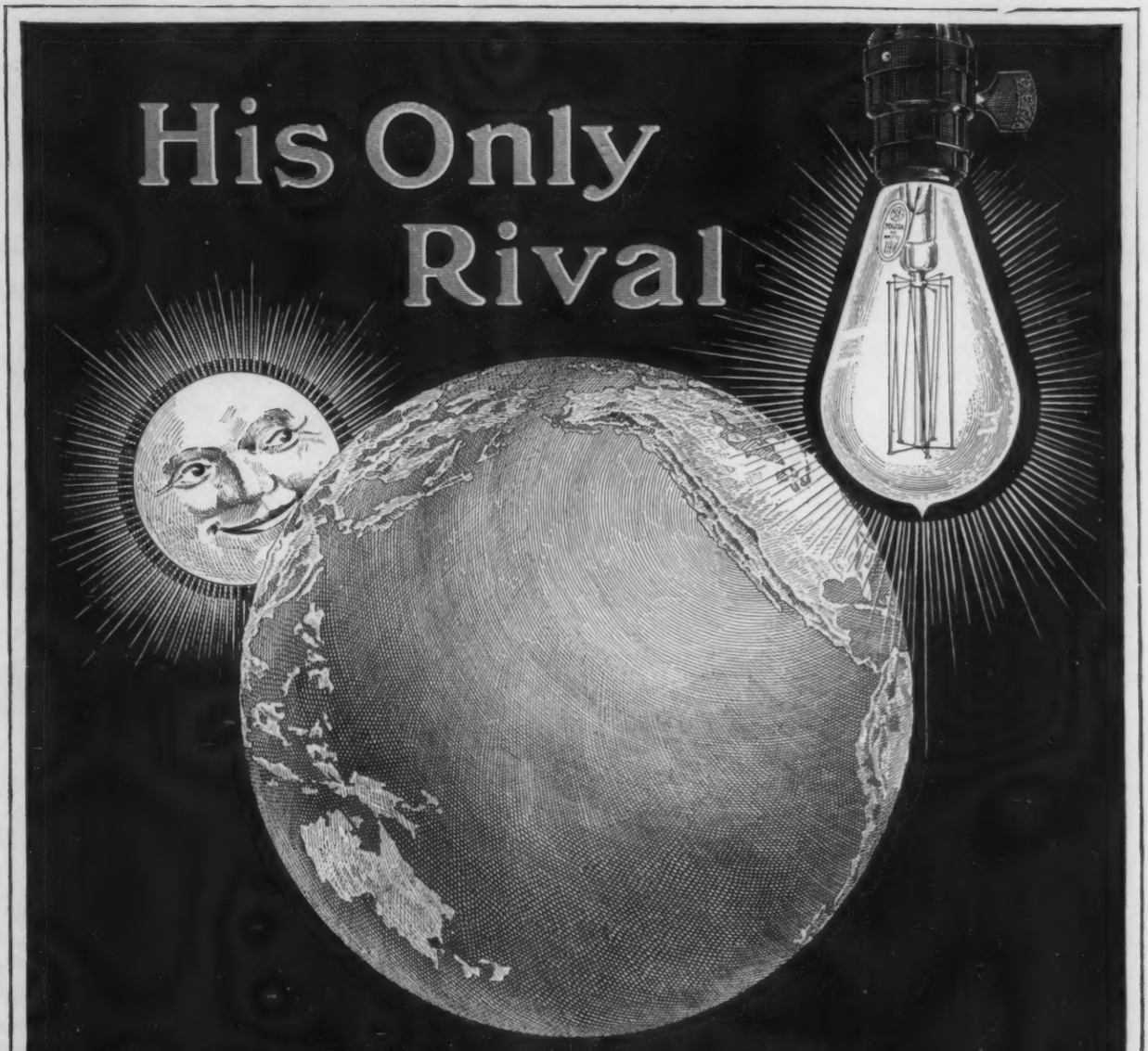

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